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AGRICULTURAL RESEARCH LANDBOONAVORSING 1992

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AGRICULTURAL RESEARCH LANDBOONAVORSING 1992

AGRICULTURAL RESEARCH

LANDBOONAVORSING



DEPARTMENT OF AGRICULTURAL DEVELOPMENT
DEPARTEMENT VAN LANDBOU-ONTWIKKELING

Type-set and published by the Department of Agricultural Development
and obtainable from the Director of Agricultural Information,
Private Bag X144, Pretoria 0001

Geset en uitgegee deur die Departement van Landbou-ontwikkeling en
verkrygbaar van die Direkteur, Landbou-inligting, Privaatsak X144,
Pretoria 0001

Printed in the Republic of South Africa by the Government Printer,
Pretoria

Gedruk in die Republiek van Suid-Afrika deur die Staatsdrukker, Pretoria

1992

ISBN 0-621-14532-7

AGRICULTURAL RESEARCH
LANDBOUONTOEWYSPONDERING
1992



DEPARTMENT OF AGRICULTURAL DEVELOPMENT
DEPARTAMENT VAN LANDBOU-ONTWIKKELING EN VERKRYGBAARHEID

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Karoo	K	Karoo
Natal	N	Natal
Transvaal	T	Transvaal
Free State	V	Vrystaat
Winter Rainfall	W	Winterreën

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Note: The Department issues a separate list of research workers and lecturing staff, which is obtainable on request from the Directorate of Agricultural Information, Private Bag X144, Pretoria 0001. Information in this edition covers the era 1991.04.01 – 1992.03.31.

Let wel: Die Departement reik 'n aparte lys uit van navorsers en doserende personeel, wat op aanvraag verkrygbaar is van die Direktoraat Landbou-inligting, Privaatsak X144, Pretoria 0001. Inligting in hierdie uitgawe dek die tydperk 1991.04.01 – 1992.03.31.

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PLANT PRODUCTION PROMOTION

AGRONOMY RESEARCH

Oil and protein seeds

GROUNDNUTS

- Nutrition*

GG.2131/05/1/5:

FOLIAR APPLICATION OF SEAWEED EXTRACT ON GROUNDNUTS. 1985-1989
C.J. Swanevelder

A product from seaweed extract (kelp) was tested at Potchefstroom during the 1985/86 and 1986/87 seasons. Seaweed extract was applied at 21, 42 and 63 days after emergence at the rate of 0, 1 and 2 l ha⁻¹ during the 1985/86 season. Because no response was measured the treatments were changed to 0, 1, 2 and 3 l ha⁻¹ applied at 30, 60 and 30-60 days after emergence. The groundnuts were produced the normal way and sprayed with a hand spray at the different treatment dates. The results are shown in Tables 2 and 3.

None of the seaweed extract-treated plots differed significantly from the control plot.

Treatment with seaweed extract had no significant effect on yield components although differences occurred with shelling percentage. No definite patterns were observed. Under the conditions that prevailed at Potchefstroom where the trials were conducted, the treatments had no beneficial effect and seaweed extract thus cannot be recommended as a practice to improve yields.

TABLE 2 - Pod and seed yields and shelling percentage of groundnuts treated with seaweed extract during the 1985/86 season at Potchefstroom

Treatment kg ha ⁻¹	At days	Pod yield kg ha ⁻¹	Seed yield kg ha ⁻¹	Shelling percentage
Control		1279	1035	70,5
1l	21	1344	1069	69,7
1l	42	1181	880	70,1
1l	63	1411	1099	69,5
2l	21	1373	1116	70,2
2l	42	1349	1081	69,3
2l	63	1346	1079	70,2
CV %		8,0	9,4	2,0
LSD (5 %)		183	170	2,4

TABLE 3 - Pod and seed yields and shelling percentage of groundnuts treated with seaweed extract during the 1986/87 season at Potchefstroom

Treatment kg ha ⁻¹	At days	Pod yield kg ha ⁻¹	Seed yield kg ha ⁻¹	Shelling percentage
Control		7683	5351	68,4
1l	30	6883	5086	73,8
1l	60	7198	49279	68,3
1l	30 & 60	7305	5751	78,6
2l	30	6893	4918	72,1
2l	60	6047	4927	81,3
2l	30 & 60	6648	4734	71,4
3l	30	6615	5366	81,1
3l	60	6526	5098	78,2
3l	30 & 60	6801	4625	67,8
Mean		6860	5078	74,1
CV %		13,3	15,5	7,5
LSD (5 %)		1569	1354	9,5

Other agronomy crops

COTTON

- Pests*

TK.2141/20/2/7 and
TK.2142/20/2/4:

THE DEVELOPMENT OF INFRA-RED MEASURING TECHNIQUES FOR THE
DETERMINING OF NEMATODE INFESTATIONS IN COTTON AND TOBACCO. 1980-1989
M.S. Greeff

Objectives and procedures

This investigation was done to determine the effect of nematodes, interacting with moisture stress, on spectral parameters; association of plant and spectral characteristics as influenced by nematodes and the potential use of spectral properties to diagnose nematode problems in the field.

Three replicated greenhouse trials with cotton, tobacco and maize were conducted using *Pratylenchus zae* and *Meloidogyne incognita* at different inoculation levels under moisture stress and no-moisture stress conditions. Measurements were made of various plant parameters, including leaf anatomy and chlorophyll concentration as well as nematode numbers in soil and roots. Reflectance, transmittance and absorptivity of top and bottom leaf surfaces were determined, using a Model LI-1800 spectroradiometer. A succession of statistical procedures was used to identify specific wave length intervals at which treatment effects might be differentiated.

Results

1. The negative effects of nematodes on all plant parameters were evident in reduced reflectance and increased transmittance. Absorptivity, being a function of reflectance and transmittance, was also affected.
2. Leaf chlorophyll content was influenced by nematode infestations, resulting in changed spectral properties, intensified when moisture stress was applied.
3. The effect of leaf thickness on spectral properties can be direct, owing to reduced mesophyll, or indirect as it affects chlorophyll content, which in turn affect absorptivity.
4. Variation in spectral properties of leaves of cotton, tobacco and maize is accounted for by the combination of soil and root nematode counts, fresh mass of aerial plant parts, top internode length, leaf chlorophyll content and leaf thickness.
5. Under the conditions of this study, moisture stress did not have an effect on spectral properties in the lower wave length regions (0,390-1,100 μm). These wave lengths can possibly be used to distinguish between moisture and nematode stress.
6. The effect of nematode stress on spectral properties may be identified at the following wave bands: reflectance from 0,502-0,708 μm , transmittance from 0,392-0,500 μm and absorptivity from 0,572-0,890 μm , for both leaf surfaces.

Information obtained during this study provides basic guidelines for further research and better interpretation of remotely sensed data.

TOBACCO

• Pathology

TK.2124/19/1/8: ISOLATION AND IDENTIFICATION OF *RHIZOCTONIA SOLANI* ON TOBACCO. 1988-1989
J.C. Meyer

The stem lesion symptom caused by *Rhizoctonia solani* is well known in the Republic of South Africa for many years. Recently a *Rhizoctonia solani* isolate was found from leafspot symptoms which could easily be mistaken for symptoms caused by *Alternaria alternata*. The close resemblance between symptoms of the two diseases is probably the reason why *Rhizoctonia* disease of tobacco leaves was not suspected.

In this study isolates from tobacco leaves, stems and soils were obtained and artificial inoculations carried out to determine whether the isolates were able to infect stems and leaves and to find out to which anastomoses group they belong. Inoculum density of the fungus in the soil was also determined by using a selective medium. By incorporating small amounts of special fungicides in a potato-dextrose-agar medium, growth of *Alternaria alternata* Keisler was inhibited to such an extent that *Rhizoctonia solani* could be isolated from the leaf lesions.

All isolates tested were able to cause "damping off", "sore shin" as well as leaf spot symptoms. This indicates that no differentiation exists between isolates, although some isolates (from tobacco leaves) fruited on a potato-marmite-dextrose-agar medium. Other isolates did not form the perfect stage at all. The isolates obtained from infected tobacco leaves, belongs to the AG 3 tester strain. The phase in which the organism exists and the structure responsible for infestation (mycelia or basidiospores) may possibly determine the degree of infestation.

TK.2142/19/1/9: THE ARTIFICIAL INFESTATION OF PLANTS AND SOIL WITH *RHIZOCTONIA SOLANI*.
1988-1989
J.C. Meyer

Objective and procedures

The aim of this study was to find a fast and simple method to infest tobacco plants as well as soil artificially with *R. solani* to enable the plant breeders to breed for resistance and to find chemical control measures.

Several techniques were used to obtain a reliable infection method. Firstly, sterilised soil in pots was inoculated with different amounts of the fungus inoculum grown on a maize meal/sand mixture. Tobacco plants were planted in the pots and placed in a greenhouse for three weeks at $\pm 26^{\circ}\text{C}$. Infestation levels were measured according to an index of 0,5-5,0, where 0,0 is no infection and 5,0 is 100 % infection.

In a second experiment *R. solani* was grown in Erlenmeyer flasks on a liquid medium. The mycelium obtained this way was washed in sterilised water and specific amounts were placed in the soil on growing tobacco plants in pots and the infection index determined as previously described.

To infect tobacco leaves artificially the leaves were placed on moist filter paper under belljars and either pieces of agar with *R. solani* mycelium, maize meal/sand culture of the fungus or *R. solani* in agar gel form, were placed on the detached leaves and incubated at 26°C for seven days, whereupon it was examined for infections.

The sexual stage of *R. solani* (*Thanatephorus cucumeris*) is very difficult to obtain. Several techniques were tried, including the Nutrient-step-down-technique, where the fungus was first grown on a rich medium and then changed to a medium lacking nutrients. In another technique potato-marmite-dextrose-agar medium was used, covered with pasteurised sand and kept moist.

The cultures were inspected every day for the formation of basidiospores.

In another experiment 1 cm-diameter filter paper discs impregnated with fungicides were placed on petri-dish cultures of *R. solani* to try and induce spore formation.

Results

Stem necroses with *R. solani* could be induced by placing the inoculum in the top soil of the pots before transplanting or by placing the liquid suspension in the soil after transplanting.

Leaf symptoms could be obtained when agar/mycelium pieces were placed on detached leaves, with a better result if they were placed on the bottom of the leaf.

The sexual stage could be induced using the potato-marmite-dextrose agar medium covered with sterilised soil after 10 days.

It was possible to infect tobacco leaves with the basidiospores.

HORTICULTURE RESEARCH

Tuber crops

POTATOES

• Physiology

GS.2411/03/1/4:

GROWTH AND PHOTOSYNTHETIC RATE OF POTATOES (*SOLANUM TUBEROSUM* L.)
AT HIGH TEMPERATURES. 1988-1989

J.A. de Jager

The effect of high temperatures on the growth and development of a number of South African potato cultivars was investigated. The cultivars Up-to-date, R100 and Buffelspoort were subjected to three day temperatures (22, 27 and 32°C) in growth chambers, whereas the night temperature was kept constant at 17°C . Foliage growth increased with increasing temperature up to 27°C , thereafter it decreased as temperature increased to 32°C . As temperatures increased, the number of tubers decreased. At an early stage of harvest, tuber yields were lower at 27°C compared to 22°C , whereas tubers occurred at 32°C . With an increase in temperature the total mass of the plants also decreased. The cultivars varied in response to temperature with regard to plant height, leaf area, leaf mass, tuber mass and total mass.

The effect of a 10-day heat stress on two growth stages was investigated. The cultivars Up-to-date, Buffelspoort and R100 were stressed at 14-24 and 50-60 days after emergence. The early stress was more detrimental than the later stress on the number and yield of tubers. The cultivars varied in response to the temperature treatments with regard to leaf area, leaf mass and total mass.

The effect of temperature on photosynthetic rate and leaf diffusive resistance was determined in growth chambers. On 50 and 60 days after emergence, plants from the cultivars Up-to-date, R100 and Buffelspoort were moved to a growth chamber where the temperature was first raised in steps of 5°C each hour from 15°C - 40°C , and then decreased to 20°C . At each temperature level the photosynthetic rate and leaf diffusive resistance was measured on the youngest mature leaf of each plant. Photosynthetic rate decreased above 20°C for all the cultivars. At 40°C photosynthetic rate was 37 % of the rate at 20°C . The greatest reduction in photosynthetic rate occurred with Up-to-date. Leaf diffusive resistance tended to be lowest

between 20 and 25 °C, increasing with an increase in temperature to 40 °C. In a similar experiment, air temperature was kept constant at 20 °C, whereas the soil temperature was increased in steps of 5 °C every two hours from 15-40 °C. At 40 °C photosynthetic rate was 72 % of the rate at 20 °C. No indication of cultivar differences occurred. The decrease in photosynthetic rate could not be attributed to an increase in leaf diffusive resistance.

With an increase in radiation intensity from 210-602 $\mu\text{mol m}^{-2} \text{s}^{-1}$, photosynthetic rate increased linearly for Up-to-date, R100 and Buffelspoort. R100 had the highest photosynthetic rate at 1 750 $\mu\text{mol m}^{-2} \text{s}^{-1}$, thereafter increasing with radiation.

Pome and stone fruits

APPLES

• Physiology

VV.2441/03/4/2:

EFFECT OF DIFFERENT NITROGEN SOURCES ON THE UTILISATION OF NITROGEN FERTILISERS BY APPLES. 1985-1990

J.F. de Villiers

Absorption of NH_4^+ and NO_3^- by Topred apple trees grafted on M793 rootstock, Nectared 9 peach trees on peach seedling rootstock and Peekapapa apricot trees on apricot seedling rootstock, were investigated in sand culture in trees grown in 45 liter glazed earthenware containers. From 100 % bud-break of vegetative buds, and at 6-week intervals afterwards, six trees of each fruit type were randomly selected and transferred to a screen house with a fibreglass roof. Each of these trees received 4 litres of the standard Hoagland's solution in which either the NH_4^+ or NO_3^- ions were labelled with 10 % atom excess ^{15}N . Nitrification in the nutrient solution was inhibited by addition of nitrapyrin. N uptake was calculated from the ^{15}N atom excess percentage in the plant tissue and nutrient solution determined in a Jasco N-150 atomic emission spectrophotometer after Dumas combustion.

For all three types of fruit trees nitrogen was preferentially absorbed as NH_4^+ in a system which contained equal amounts of N as NH_4^+ and as NO_3^- . For total N absorbed apricot trees showed the least preference for NH_4^+ , whereas in apple and peach trees preference ranged from 30-40 %. In apple trees the ratio of $\text{NH}_4\text{-N}$ to $\text{NO}_3\text{-N}$ in different parts of the tree did not differ significantly, but in apricot and peach trees the lowest ratios were observed in leaves.

The ratio of $\text{NH}_4\text{-N}$ to $\text{NO}_3\text{-N}$ absorbed was not significantly affected by sampling date in bearing or non-bearing apple trees. However, sampling date had a highly significant effect ($P < 0.01$) on the ratio of $\text{NH}_4\text{-N}$ to $\text{NO}_3\text{-N}$ absorbed by bearing and non-bearing apricot trees. During the period from mid-December to the beginning of March, when approximately 63 % of the seasonal requirement of bearing apricot trees was assimilated, $\text{NO}_3\text{-N}$ was preferentially absorbed. In bearing peach trees $\text{NH}_4\text{-N}$ was preferred at the end of October and $\text{NO}_3\text{-N}$ at the beginning of April. At all other sampling dates the ratio of $\text{NH}_4\text{-N}$ to $\text{NO}_3\text{-N}$ absorbed by both bearing and non-bearing peach trees ranged between 1.24 and 1.43. Clearly, the presence of fruit resulted in other metabolic changes which affected the trees ability to assimilate $\text{NH}_4\text{-N}$. The reasons for these differences are most likely to be the way plants utilise these N sources. Competition from above-ground metabolic processes may affect the availability of organic compounds and thus the assimilation of $\text{NH}_4\text{-N}$.

Differential utilisation of $\text{NH}_4\text{-N}$ and $\text{NO}_3\text{-N}$ by fruit trees could play an important role in ensuring optimum fruit composition and storage potential as well as decreased N fertiliser rates and concomitant environmental advantages. Preference for either N source is, however, dependent on the presence or absence of fruit and seasonal variation is observed. Before these results can be fully utilised in practice the investigation will be continued in large leaching lysimeters.

VV.2441/03/6/12:

OPTIMISATION OF DPA TREATMENT AGAINST SCALD OF APPLES. 1986-1989

S.J. van Eeden

The object of this study was to determine the optimum concentration of diphenylamine (DPA) to be applied to apples of different stages of maturity. Granny Smith and Starking apples were harvested weekly over a four-week period, starting at 2 weeks prior to optimum picking maturity until 1 week afterwards. The apples were treated with DPA concentrations ranging from 0-2 500 mg dm^{-3} and stored in regular and controlled atmosphere. Tests were carried out over a three-year period.

The incidence of scald development varied between seasons but the DPA concentration required for superficial scald control was almost the same for all seasons. Recommendations are based on the season with the highest occurrence of scald.

Many Starking apples picked at early maturity stages developed scald when stored in regular atmosphere, and 2 500 mg dm⁻³ DPA was necessary for scald control. However, during the later picking stages 1 500 mg dm⁻³ DPA was sufficient for scald control. Starking apples stored in controlled atmosphere only developed scald when picked before the optimum picking stage, and sufficient control was obtained with 1 500 mg dm⁻³ DPA.

Granny Smith apples stored in regular atmosphere required 2 500 mg dm⁻³ DPA during the first two picking stages and 1 000-1 500 mg dm⁻³ DPA during the later stages for scald control. During controlled-atmosphere storage of Granny Smith, scald was controlled with 1 500 mg dm⁻³ DPA for all picking stages.

• Pathology

VV.2441/19/1/6:

ISOLATION TECHNIQUES FOR COLLAR AND ROOT ROT PATHOGENS OF APPLES.
1985-1990

W.A. Smith

The main objective was the development of isolation techniques and techniques for zoospore, chlamydospore and oospore formation of *P. cactorum*.

It was found that a quantitative and a qualitative assay of various *Phytophthora* species could be determined from plant tissue, soil and water samples.

An effective, multi-purpose selective medium for the slow-growing *Phytophthora* species was developed, namely P5R25B10H5 (clarified 10 % V-8 agar supplemented by pimarinic, rifampicin, benomyl and hymexazol at 5, 25, 10 and 5 mg/dm³, respectively). All concentrations were based on active ingredients. The reduced pimarinic concentration allowed germination of survival propagules, chlamydospores and oospores of *P. cactorum* on the selective medium.

Baits, with apple leaf discs as the most sensitive and effective, were too readily colonised by fast growing *Pythium* species.

The optimum temperature for release of zoospores of *P. cactorum* differed from that of *Pythium* species. Based on these results a procedure was developed to detect and quantify *P. cactorum* in naturally infested soil.

Factors that influenced chlamydospore production of *P. cactorum* were sterols, aeration, light and temperature.

Light was the most critical factor that affected the germination of oospores of *P. cactorum*. Light was not required after activation had occurred.

The incubation temperature during oospore development was important for subsequent oospore germination. Calcium accelerated the rate of oospore activation. Aging of oospores increased the germination of *P. cactorum*.

All technique procedures developed under this facet are combined together in a laboratory manual and will serve as part of the "materials and methods" of future articles on root diseases.

The acquisition of effective isolation techniques had to precede studies on the molecular plant pathology in future.

PEARS

• Physiology

VV.2442/03/1/1:

MICRO-PROPAGATION OF PEAR ROOTSTOCKS. 1988-1990
L.A. Allderman

In the western Cape, rooting of hardwood cuttings of BP1 and BP3 pear rootstocks (*Pyrus communis* L.) by conventional methods is unpredictable. Propagation using in vitro techniques were therefore investigated.

Single node sections of semi-hardwood cuttings of PB1 and PB3 were cultivated on various media, hormones and concentrations of hormone. A suitable initiation medium was developed for this purpose. Commercially viable proliferation rates were achieved by harvesting shootlets but retaining the basal mass of axillary buds.

The effect of type and concentration of hormone on rooting of BP3 microcuttings were determined. High percentage rooting (80 %-100 %) was achieved.

Differences in growth habit between juvenile and mature-like growth phases of BP3 was also determined.

This study resulted in a commercially viable method for the micropropagation of BP1 and BP3 pear rootstocks.

- *Nutrition*

VV.2443/05 1 4:

RATE AND DEPTH OF NITROGEN LEACHING IN PEACH ORCHARD SOIL UNDER MICRO-IRRIGATION. 1984-1990

K.D. Fuller

In this study, the effect of nitrogen (N) source, irrigation regime and stage at which N fertiliser is injected into the irrigation system (pulse stage) on the redistribution of applied N in the soil was investigated. In all cases, concentrations of applied ammonium generally decreased with depth with no prominent peaks below the uppermost 50-cm depth increment, except where fertiliser solution was introduced during the first and second quarters of irrigation by volume (pulse stages 1 and 2).

Regardless of pulse stage, the difference in total movement of applied NH_4^+ and NO_3^- -N was greater when 58 as opposed to 23 mm of irrigation water was applied. As the pulse stage was progressively retarded, the difference in the total movement of applied NH_4^+ and NO_3^- increased. In all cases, the negatively charged nitrate ion moved to greater depths than its positively charged counterpart. Treatments receiving 58 mm of N containing irrigation water, corresponding to the lower depletion level of PAW, also resulted in movement of N to greater depths.

A comparison was drawn between the observed and predicted movement of ammonium nitrate applied at two stages during irrigations of 23 and 58 mm on the Clovelly coarse sandy soil. It was found that the computer simulation model, LEACHN, was capable of predicting expected differences in the simulated movement of both NH_4^+ as well as NO_3^- at two different pulse stages on this soil. In general, fair agreement between the observed and predicted redistribution of nitrogen at the 23-mm irrigation level was obtained. At the 58-mm irrigation level, however, LEACHN tended to under-estimate the flux of water and nitrogen in this soil, especially at pulse stage 1. Examination of the simulations obtained for two Oakleaf soils also revealed that the model was capable of distinguishing between pulse stages with regard to N movement during a single application of water. However, the similarity between the predicted movement of NH_4^+ as well as NO_3^- at both pulse stages on these two soils indicated that the model may not have been capable of distinguishing between soils of diverging hydraulic properties.

The study showed that the choice of N source, irrigation regime and pulse stage can be used successfully to manipulate the redistribution of applied N in the root zone of a perennial crop on sandy soils using micro-sprinkler irrigation. It is expected that application of the fertigation technique in situations where correct irrigation scheduling is not always possible should lead to improved utilisation of applied N compared to situations where N is applied conventionally. The benefits of this research include optimisation of production and tree vigour through increased utilisation of applied N, less wastage of applied fertiliser N by leaching, smaller fertiliser N inputs and, therefore, also a reduction in nitrate pollution of water systems.

- *Crop science*

VV.2443/30/1/6:

MORPHOLOGY OF PEACH POLLEN FOR CULTIVAR IDENTIFICATION. 1986-1990

P. van der Merwe

The aim of the study was to determine the significance of peach and nectarine pollen sculpture in cultivar identification.

A scanning electron microscope study of the pollen sculpture of 38 cultivars from Roodeplaat, Pretoria and Bien Donné, Franschhoek revealed that the extent of variation of pollen sculpture within and between cultivars is such that the usual descriptive methods can rarely separate more than one out of ten cultivars. Computer-assisted methods such as image recognition, image processing and image analysis will probably fare better.

Pollen sculpture and anatomy can be a valuable assistance when added to the 80 or more characteristics normally used to describe new cultivars. It is, therefore, strongly recommended that pollen sculpture and anatomy be included in the description of all new cultivars developed at the Bien Donné Experiment farm.

A new facet will probably be registered to study new cultivars in more detail.

• *Physiology*

VV.2444/03/2/3:

THE EFFECT OF GROWTH REGULATORS ON PLUMS. 1986-1987
O.J. Olivier

The effect of an autumn application of paclobutrazol in combination with late winter applications of the rest-breaking agent DNOC winter oil emulsion (DNOC) on the the flowering pattern and flower dry mass of *Prunus salicina* cv. Songold was investigated. The Songold plum cultivar tends to grow vigorously and set poor crops when adverse weather conditions cause poor pollination.

This study was aimed at normalising the vigour of such trees and to improve fruit set. DNOC as well as paclobutrazol caused earlier flowering. This effect was enhanced by combinations of DNOC and paclobutrazol. Buds from paclobutrazol-treated trees flowered earlier in 1986 independently of the DNOC application date, whereas the number of flowers that opened early was higher with later DNOC applications in the control trees. Paclobutrazol reduced the total number of flowers in both years. Paclobutrazol treatments resulted in flowers with higher dry mass. Paclobutrazol is a growth regulator that in terms of dormancy release gave results similar to DNOC but there was a difference in the mechanism of action between the two compounds in the manifestation of these effects.

As a result of the effect of paclobutrazol on the flowering pattern of Songold, it was decided to investigate the effect of paclobutrazol on the differentiation pattern of the reproductive buds of the Songold plum. A foliar application of 500 mg ℓ^{-1} paclobutrazol was applied in autumn. The effect of paclobutrazol on the dry mass and size of the reproductive buds and flowers was investigated.

After the period of retarded growth in winter, the buds from treated trees developed faster than the buds of the control trees. Ovules were present in buds from treated trees three months after the application but not in buds from control trees. The ovary developed faster as a result of paclobutrazol. There was a positive effect on the dry mass of reproductive buds and early flowers. This increase in dry mass of flowers was manifested in larger ovaries, ovules and nucellus.

These results indicated that a foliar application of paclobutrazol in autumn had an effect on reproductive development in the same winter and spring before affecting vegetative growth.

• *Pathology*

VV.2444/19/2/7:

DIFFERENTIAL HOST X PATHOGEN INTERACTIONS AMONG CULTIVARS OF PLUM
AND STRAINS OF PSEUDOMANADS. 1988-1990
Isabel M.M. Roos

Different strains of *Pseudomonas syringae* were compared by inoculating shoots of five plum and three apple cultivars in greenhouse tests. Aggressiveness was based on lesion length 2 months after inoculation, converted to a percentage of shoot length.

Invasiveness was expressed by population distribution index (PDI) based on the level of *P. syringae* present in suspensions of individual shoot segment, leaves, and petioles. Two-way analysis of variance of the data indicated significant cultivar x strain interactions, but host-pathogen interactions varied more on plum than on apple. Four extremes were found: little or no growth of the pathogen within the host with small or no lesions; systemic spread with small, restricted lesions; pathogen confined to lesions; and extensive spread of pathogen beyond the lesion.

Apple appears to be an inhostipable host. The results indicate that aggressiveness of strains as well as the ability of these strains to spread systemically in the host should be taken into account during evaluation and selection for bacterial canker resistance in plum.

VV.2444/19/2/8:

VIRULENCE OF PATHOGEN STRAINS OF BACTERIAL SPOT DISEASE ON PLUMS.
1988-1990
H.J. du Plessis

Virulence of strains of *Xanthomonas campestris* pv. *pruni* to apricot, peach and plum cultivars was determined after inoculation of detached leaves and leaves on trees in a greenhouse. Virulence of the pathogen was also investigated by scanning electron microscopy (SEM) after inoculation of leaves of nectarine, and fruits and seeds of plum. Polyacrylamide gel electrophoresis of soluble proteins and total DNA of *X. campestris* pv. *pruni* was performed to determine if strains that differed in virulence, could be distinguished by their protein and genomic fingerprint profiles.

Differential virulence was exhibited by *X. campestris* pv. *pruni* strain Xcp2 on detached leaves and leaves on trees of plum cultivars Golden King, Reubennel and Songold. Some strains were also differentially virulent to detached leaves of peach cultivars Olympia, Bokkeveld and Hanntam. A highly significant ($P > 0.001$) interaction of linear decline in the numbers of spots and *X. campestris* pv. *pruni* bacteria recorded from the first to the fourth leaf from the shoot tip, occurred among cultivars.

A SEM study showed that unlike aggressive strain Xcp3, differentially virulent strain Xcp2 did not multiply on or inside Olympia nectarine leaves. Non-typical greyish-white spots that developed on surfaces of nectarine leaves 14-21 days after inoculation with Xcp2, appeared to be a hypersensitive reaction of the host plant. SEM also indicated that the pathogen frequently invades fruits and seeds of plum systemically through the stalks.

The selection and evaluation of bacterial spot resistance of apricot, peach and plum cultivars might be influenced substantially by the strains of *X. campestris* pv. *pruni* and the age of leaves used in screening. Screening for resistance should be performed on the first fully unfolded leaf from the tips of actively growing shoots in the greenhouse and with strains representative of the complete range of differential virulence known to occur in *X. campestris* pv. *pruni*.

All 20 *X. campestris* pv. *pruni* strains investigated exhibited a similar protein pattern of major bands but generally had different sharp and faint or broad and diffuse bands. Three distinct groups of strains, each with identical protein patterns, were not correlated with virulence or geographical origin. The strains also displayed identical genomic fingerprints. Polyacrylamide gel electrophoreses of soluble proteins and genomic DNA could prove to be an invaluable aid to the rapid and precise identification of *X. campestris* pv. *pruni*, and to the study of the epidemiology of diseases caused by phytopathogenic bacteria.

APRICOTS

• Technology

VV.2445/52/1/2:

FACTORS AFFECTING QUALITY OF DRIED APRICOTS. 1987-1989
P.C. Fourie

The objectives were to study the effects of maturity and cold storage on the quality of dried apricots and peaches. Peeka apricots and Elberta peaches from different areas were used in the investigation. The effect of total soluble solids content (Brix) and size of fresh fruit on the quality of the dried product was investigated. The effect of cold storage prior to drying on quality was also investigated.

The total soluble solids content of fresh apricots and peaches were both indirectly proportional to the drying ratio. The drying ration decreased as the Brix of the fresh fruit increased.

The ideal fresh-size for production of large and extra large dried apricots was 40 mm and bigger. This will not necessarily increase the percentage extra large dried apricots, but the percentage medium dried apricots will definitely decrease. The ideal fresh-size for the production of large dried peaches was bigger than 55 mm, but smaller than 70 mm to limit the percentage extra large dried peaches.

The combined effect of fresh-size and Brix, both directly proportional to dried fruit size, must be taken into account to assure good quality dried products. The slower translocation of moisture from the inner to the outer surface of peaches, owing to the more compact cell structure, caused less shrinkage so that the effect of Brix on dried fruit size was not as significant as in the case of apricots.

The fixed prizes paid to producers for dried fruit of similar quality increase as the dried fruit sizes increase, but in this study this tendency was not reflected in the realisation/fresh ton. The differences were probably due to the variable quality gradings of the different dried fruit sizes.

Cold storage had little effect on the quality of dried fruit and realisation of cold-stored fruit may become less, if decay is taken into consideration. However, cold storage can be used effectively to extend the processing season.

CHERRIES

• Meteorology

VV.2446/33/1/1:

INFLUENCE OF MICRO-CLIMATE ON THE INTENSITY OF BACTERIAL CANKER IN
CHERRIES. 1985-1990
L. Smit

The study was carried out on two-year-old trees of the cultivars Bing and Heidelfinger planted in the Ficksburg district on north and south facing slopes, with or without shade protection on their north-western

side. Observations of diurnal temperature under the bark and development of bacterial canker after infection with a mixture of *Pseudomonas syringae* pv. *morsprunorum* strains were studied.

Although the development of visible cankers and discolouration of tissue was not greatly affected by slope, bud necrosis tended to be more severe on a north facing slopes. Furthermore, the presence of a shade screen decreased the occurrence of cankers, discolouration and bud necrosis. These results substantiate the earlier field observation and practice.

At the first sampling date on September 7, cankers were small and little effect on bud or shoot vigour was observed. However, by September 28, the size of cankers had increased and vigour of shoots decreased. On shoots sampled on the 19 October the size of cankers did not increase, but a large number of buds were dead and vigour of shoots had declined further and tended to be poor. These results indicate that disease development tended to take place during early spring.

Maximum temperatures were reached on the eastern side of the trunk at 10:00 and on the western side 14:00-16:00 on a tree without shade. Temperatures on the southern and western sides of the trunk were 5-7 °C lower, during nights when temperatures decreased to below 0 °C. Furthermore, during warm days shading resulted in lower temperatures during the hottest part of the day, whereas higher temperatures were recorded behind a shade screen throughout the day on cooler days.

Establishment of cherry trees in the eastern Free State should not be attempted without shade protection. If trees are completely covered by shade cloth, production on north-facing slopes should also be possible. The cost of such a net will also be offset by the advantages of protection from hail and birds.

• Technology

VV.2446/52/2/1:

DEVELOPMENT OF A COLOURING PROCESS FOR CHERRIES. 1988-1989
E. Joubert

The objective of the study was the development of a process colour-fast cherries for the canning industry.

A method for the determination of erythrosine in the presence of LMP, calcium and EDTA was developed as existing methods could not be used. Model studies (steady state system) were used to determine whether calcium pectate gel could effectively bind erythrosine for industrial application to prevent leaching of erythrosine in canned fruit products.

Pectin and calcium decreased the absorbance of erythrosine significantly ($P < 0,05$) at λ max. (526 nm) compared to the control, whereas absorbance increased at 550 nm with pectin. A bathochromic shift of 2 nm occurred in λ max. The changes in absorbance resulted in a visible colour change from orange-red to red. This indicated interaction between pectin and erythrosine.

Measurement of absorbance at 537,3 nm eliminated the effect of pectin and calcium. Beer's law was observed for erythrosine concentrations 0-10 $\mu\text{g}/\text{m}$ ($r = 0,9999$). EDTA did not affect absorbance significantly. For instruments measuring absorbance at 1 nm intervals, 534 nm instead of 537,3 nm should be used.

Diffusion of erythrosine from Ca pectate gel showed zero retention and thus fixation of erythrosine by the gel in a high pH medium. The use of alginate have no advantages over pectin, since the mechanism of erythrosine fixation also depends on the carboxyl-calcium-bridges. No alternative method presently exists for erythrosine fixation, except through pH manipulation, which proved to be inadequate.

Berry fruits

BERRIES

• Water requirements

VV.2451/31/1/1:

BERRIES, EFFECT OF SOIL MOISTURE REGIME AND IRRIGATION SYSTEM ON WATER USE AND PRODUCTION OF STRAWBERRIES. 1988-1990
J.H.M. Karsten

The effects of irrigation systems and irrigation scheduling on the production of Tiobelle strawberries were evaluated in two experiments on the Bienne Donne Experiment Farm.

In the first experiment a full-surface irrigation system was compared with drippers on the soil surface beneath the plastic mulch and with drippers at a depth of 200 mm. Irrigation scheduling was based on daily evaporation from a Class A pan using crop coefficients of 0,25 and 0,50 for the full-surface system and 0,13 and 0,25 for the drip systems.

In the second experiment the same irrigation schedules were followed to compare full-surface irrigation with drip irrigation whereas two fertilisation levels were applied.

In both experiments irrigation scheduling had a significant effect on both total fruit yield and mean fruit size. In the first experiment a yield of more than 30 t h⁻¹ was obtained with the higher crop coefficient. Smililar results were obtained in the second experiment, but a 38 % lower yield and better fruit size during the peak period were obtained owing to a longer pre-cooling period and later planting date.

The different irrigation systems had no effect on yield of fruit size, but 50 % less water was used by the drip system compared with full-surface irrigation.

Oenology/Wynkunde

WINE

• Microbiology

WW.2471/08/1/1:

EVALUATION OF COMMERCIALY DRIED YEASTS AND THE DEHYDRABILITY OF PROMISING YEAST STRAINS. 1975-1988

E.E.J. Simpson

Since the commencement of this facet in 1975, active dried wine yeast (ADWY) has come a long way. In 1974 only one small experimental batch of Epernay ADWY was dried locally, in comparison with 10 batches (about two tons each) of seven different yeast strains dried for the 1988 pressing season. A large number of promising yeast strains were evaluated on different grounds to determine their oenological properties. Some of these strains were dried commercially and were later replaced by newly selected more suitable strains.

The microbiological quality of the ADWY batches was tested and on a few occasions it was recommended to the manufacturer to withdraw a particular batch from the market. The fermentation ability of the different batches was also tested in various musts.

The microbiological quality of locally produced ADWY compared favourably to that of imported strains and also complied well with the international quality guidelines.

Low storage temperatures are essential for the survival of ADWY, even for short periods of time. Room temperature is not desirable. All ADWY must be stored below 15 °C preferably at 0 °C-4 °C. Rehydration is rather critical and therefore temperatures between 35 °C and 39 °C are recommended.

• Chemistry

WW.2471/53/3/1:

WINE: ENZYMATIC RELEASE OF BOUND TERPENES IN GRAPES AND MUST. 1986-1989

L.H. Strauss

This project is a study on the ability of seven different enzymes to release glycosidically bound monoterpenes in Muscat d'Alexandrie and Weisser Riesling musts.

Flavour in wines is perhaps the most important factor affecting wine quality, with monoterpenoids being among the compounds contributing to flavour. In grapes there exist glycosidically bound forms of these monoterpenes, representing a latent source of aroma.

Seven different commercial enzyme preparations were characterised with respect to their catalytic properties and fractioned by ion exchange chromatography in the most active fractions. Amongst those commercial preparations tested, Rohapect C was found to be the most effective at conditions prevalent during wine making.

These purified fractions were added to the above-mentioned grapes to determine their effect on the release of different monoterpenes. Even though the enzymes were active on synthetic substrates, limited release of terpenes from must could be detected.

Possible causes for this apparant inability to release monoterpenes were investigated. Product inhibition owing to the presence of high concentrations of glucose in the must appeared to be the main cause of limited enzyme activity.

In an attempt to overcome this problem, glucose in the above-mentioned cultivars was oxidised to gluconic acid by glucose oxidase, prior to attempting monoterpene release by Rohapect C. Although no marked increase in the release of total terpenes occurred, a significant increase in the concentrations of some individual terpenes could be observed. The effect of this on wine quality remains to be ascertained.

Citrus and subtropical crops

CITRUS

• Pathology

SS.2481/19/2/4:

RESISTANCE OF BITTER SEVILLE CITRUS ROOTSTOCKS TO TRISTEZA. 1969-1990
S.P. van Vuuren

Citrus tristeza virus (CTV) disease is endemic to S.A. and therefore Bitter seville can not be used as a rootstock for sweet orange owing to the sensitivity of this combination to CTV. As a rootstock, Bitter seville is tolerant to *Phytophthora* root rot, gives fruit of high internal quality and it shows a degree of tolerance to citrus blight. These advantages of Bitter seville rootstock justified the evaluation of many selections for tolerance to CTV. An alternative approach was to use mild CTV strains to protect this sensitive rootstock/scion combination against natural severe infections.

More than 60 Bitter seville selections were tested for CTV tolerance. None of these selections showed tolerance. One tree, probably a hybrid, grew well despite being infected with severe CTV. The scion of this tree was removed and the rootstock allowed to grow out, whereafter it was multiplied for seed production purposes. Further evaluation of this material awaits seed production.

Gou Tou Bitter seville, which originated from Mainland China, was compared to conventional Bitter seville as a rootstock for sweet orange. After five years Valencia trees on Gou Tou Bitter seville rootstock were slightly affected by a severe CTV isolate. The same isolate killed similar trees on conventional Bitter seville rootstock. Gou Tou Bitter seville developed stem pitting symptoms even if inoculated with a mild CTV isolate.

Eleven mild CTV isolates from Florida (USA), Israel and South Africa were evaluated with sweet orange on Bitter seville rootstock. The trees were planted in an orchard where they were exposed to natural reinfections. Quick decline symptoms appeared four years after planting in the presence of some mild CTV isolates. Only one isolate, Micveh T from Israel, appeared to have potential commercial value under the climatic conditions in which they were tested.

SS.2481/19/3/2:

CITRUS: SCREENING FOR RESISTANCE TO *PHYTOPHTHORA* IN CITRUS IN THE
LABORATORY AND THE GLASS-HOUSE. 1988-1990
N.M. Grech

Nature and extent

This study was undertaken to develop laboratory and glasshouse procedures for the identification of *Phytophthora*-resistant citrus.

Specific results

Rough lemon (susceptible) and Gou-Tou (resistant) rootstocks were inoculated with *Tylenchulus semipenetrans* and *Phytophthora parasitica* and *P. citrophthora*. The nematode and *Phytophthora* populations increased during the course of the experiment. The rough lemon plants developed typical root rot symptoms whereas the Gou-Tou plants did not. The dry mass of the roots of the inoculated Gou-Tou plants was greater than that of the inoculated rough lemon roots. The dry mass of the uninoculated rough lemon roots was significantly higher than that of the inoculated rough lemon plants. The dry masses of the inoculated Gou-Tou and uninoculated plants did not differ significantly from one another.

The Gou-Tou cultivar showed a higher tolerance to infection by both the citrus nematode and *Phytophthora* than did the rough lemon cultivar. These results indicate that field trials should be undertaken to assess the horticultural and other pathological characteristics of both cultivars.

A second experiment was undertaken to determine whether multiple infections involving CTV, CEV, the citrus nematode and *Phytophthora*, in various combinations, showed any synergistic effect on the growth and development of rough lemon seedlings in the glasshouse. The greatest damage was caused by *Phytophthora*. The viruses offered no protection against either the citrus nematode or *Phytophthora*.

A third study was undertaken to determine the chronic effects of *Phytophthora* infection on rough lemon nursery trees.

• *Pests*

SS.2481/20/1/5:

CONTROL OF FALSE CODLING MOTH IN CITRUS. 1971-1990
C.D. Thomas

Extremely high citrus crop losses owing to the false codling moth, *Cryptophlebia leucotreta* (Meyrick), have been reported in the past, although since 1982 national average loss has dropped from more than 10 % to approximately 2 % of yield. In view of the cost of treatment and the fact that it jeopardises export potential, the pest remains a critical threat to the industry. Research has concentrated on four aspects of the pest management.

Control with insecticides is now possible with applications of two registered chitin synthesis inhibitors.

As an alternative, false codling moth may be controlled by properly managed, weekly releases of laboratory reared egg parasitoids, *Trichogrammatoidea cryptophlebiae* Nagaraja. Much of the research since 1982 has concentrated on why earlier results were variable. Features of the searching ability of the parasitoid about the tree and its functional response to large numbers of eggs on individual fruit, were found to be responsible for this variation. High volumes of releases at 80 000 parasitoids per hectare per week can overcome these problems, and are as efficient as chemical control.

Biological and chemical control methods are both relatively expensive and a much needed monitoring system, based on synthetic female sex pheromones, has been developed. Early commercial formulations of the two major pheromone components, (E)-8-dodecenyl acetate and (Z)-8-dodecenyl acetate, have been modified, through research, to a more efficient blend which is species specific to *C. leucotreta*. Ideal trap devices are large delta-type or wing-trap designs. Monitoring systems based on these allow more considered decisions on whether control is necessary or not; their accuracy in forecasting size and time of outbreaks can be refined with the accumulation of data in the future.

Further investigations have identified that false codling moth responds not only to fruit in a certain condition, but also that there is preferential egg laying on certain cultivars and selections, whereas others are non-preferred hosts. These facts offer a potential method of control through either selective trapping of female false codling moths, or through breeding non-preferred types. Both aspects require further research at the physiological level of both insect and host-plant.

SS.2481/20/1/7:

INTEGRATED PEST CONTROL OF CITRUS IN THE CAPE PROVINCE. 1985-1990
W.J. du Toit

The aim of this facet is the transition from a chemical to a biological means of controlling the red scale in the Cape Province. This serves as a basis for the development of an integrated pest control programme of citrus pests.

The parasitoids of the red scale in the eastern Cape became active only in middle January which impedes the application of corrective red scale sprays. The tortoise beetle, *Chilocorus nigritus*, which is an excellent predator of the red scale in the eastern Transvaal, is not suitable in the cooler eastern Cape regions. The "Sper" band/pyrethroid around the stem controls the pugnacious ant effectively for six months, whereas the sticky polybutene strip controls the ant poorly in the dusty eastern Cape conditions. A thin copper strip around the stem effectively controls the brown snail, *Helix aspersa* on citrus for at least one year. For the development of a red scale monitoring system, further studies will be necessary.

SS.2481/20/1/8:

ECOLOGY, CHEMICAL AND BIOLOGICAL CONTROL OF CITRUS MITES. 1985-1990
M.A. van den Berg

The objective of the research was to study mites on citrus. Work was mainly done on the ecology, economical importance and the control of the Lowveld citrus mite *Eutetranychus orientalis*.

The pesticides bromopropilate, chinomethionate, dicofol and triazophos effectively control the Lowveld citrus mite. Recommendations for the registration of the first three mentioned pesticides have been made.

• *Crop science*

SS.2481/30/7/1:

HIGH DENSITY PLANTING OF CITRUS/NAVELS, VALENCIAS AND GRAPERUIT.
1985-1989
H.J. Breedt

The objective of the study was to evaluate high density planting with regard to yield, fruit quality, period of

fruit ripening and identification of the optimum spacing of citrus trees on Flying Dragon trifoliolate, a dwarfing rootstock.

Results of facet SS.2481/30/7/2 confirmed the poor yield potential of Flying Dragon trifoliolate. This rootstock will probably not be suitable as a dwarfing rootstock for commercial high density plantings and because of this, the trial will not be replicated in other areas. The existing orchard will be used to study plant responses after pruning.

The facet will be terminated and a new project will be planned in order to reach the objective in a shorter period of time.

SS.2481/30/7/2: DWARFING OF CITRUS TREES. 1985-1989
H.J. Breedt

The aim of the study was to evaluate various techniques which can be used to dwarf citrus trees.

The use of Flying Dragon trifoliolate (*Poncirus trifoliata* var. *monstrosa*) as a dwarfing rootstock was proved to be the most reliable of all methods tested to control citrus tree size. Although the trees are still young, the available data showed that the yield of Washington navel, Olinda Valencia, Marsh grapefruit and Eureka lemon were unacceptable. Respectively 31, 36, 31 and 48 tons per hectare were obtained at theoretical manipulated planting densities of 2604, 1213, 1980 and 972 trees per hectare.

The aim of the facet has been partially achieved and the facet will be terminated. The results obtained from this facet will be incorporated in a new facet which will be part of the new dwarfing strategy.

SS.2481/30/8/1: FRUIT SIZE STUDIES ON CITRUS/CLEMENTINES. 1985-1989
J. Bredell

Variable production is typical of the Clementine in the south-eastern Cape. In order to ensure fruit set and annual fruit production, the application of Gibberellic acid (GA3) at full bloom is standard practice, but produces an unacceptably high percentage of unexportable small fruit. The objective of this study was to evaluate the effect of several fruit set growth regulators and thinning chemicals in terms of concentration and time of application. Trunk girdling (scoring) in conjunction with Gibberellic acid (GA3) application to minimise the production of unexportable small fruit in the above-mentioned areas, was also investigated. The experimental sites were at East Londen, Adelaide, Addo and at Paarl.

East Londen results showed that 20 mg/ℓ Cyclohexamide (SH) as a follow-up spray after a 7,5 mg/ℓ GA3 application at full bloom (FB), reduced fruit set without improvement of fruit size or percentage exportable fruit per tree or per hectare compared to the control, 7,5 mg/ℓ GA3 at FB. 300 mg/ℓ naphthalene acetic acid (NAA), as a follow-up spray to GA3 applied at FB, significantly increased both yield and percentage exportable crop than SH. Fruit size was also better than SH, but not better than that of the control.

At Adelaide production and percentage exportable fruit of 2,5 mg/GA3 at FB, was significantly higher than the unsprayed control, but only slightly better than the other GA3 treatments whereas fruit size overall was also better. Application of 2,5 and 7,5 mg/ℓ GA3 during FB at Paarl yielded significantly better than the control but 2,5 mg/ℓ yielded significantly more unexportable fruit, in contrast to the Adelaide trial. 10 mg/ℓ GA3 at full bloom followed by 10 mg/ℓ GA3 after the November drop, increased production significantly over the control with no fruit size advantage.

At Addo 7,5 mg/ℓ GA3 at FB followed by girdling (scoring) of the trunk before and after November drop gave significantly higher crops and export yields per tree and per hectare than the control - 7,5 mg/ℓ GA3 at FB or GA3 at FB followed by another 7,5 mg/ℓ before and after November drop. The latter two treatments were also significantly better than the control. Exportable small fruit production, counts 180 and 168 by the two girdling treatments, was significantly higher than the control, though not for the larger fruit. GA3 at FB plus girdling or GA3 after November drop were overall the best treatments.

Treatments at the different localities showed discrepancies but the results were mainly consistent. 2,5 mg/ℓ GA3 seems an adequate concentration for production and fruit size. GA3 at FB followed by girdling or GA3 after the November drop gave excellent results. However, the effect of continuous girdling on tree health and growth is unknown. During the trials it also became apparent that external factors such as climate and tree age can contribute to discrepancies in effectivity of GA3 applications.

AVOCADOS

• *Physiology*

SS.2483/03/3/1 and
SS.2483/03/3/2:

PHYSIOLOGICAL INDICATORS FOR THE PREDICTION OF FINAL HARVEST DATE OF
AVOCADOS. 1985-1989
J.P. Bower

The original aim of the work was to identify, by way of physiological indicators, the period during which avocados (cv. Fuerte) could be exported with acceptable losses owing to physiological disorders. This has been achieved, in that a final packing date in the northern and eastern Transvaal has been identified as the end of May. The deterioration in quality has been ascribed to abscisic acid, which in turn may be linked to pre-harvest factors.

An attempt was also made to modify the effects of the endogenous ABA levels by post-harvest treatments. It was found that modified transport container atmosphere may assist. Prevention of moisture loss from fruit and the use of controlled-atmosphere storage were most promising.

BANANAS

• *Physiology*

SS.2484/03/2/1:

DEVELOPMENT OF TISSUE CULTURE TECHNIQUES FOR THE PRODUCTION OF
EMBRYOGENIC CALLUS AND PROTOPLASTS IN BANANAS. 1985-1990
M. Fitchet-Purnell

The objective of this facet was to develop tissue culture techniques and to determine the physical and chemical factors involved in the production of embryogenic callus and protoplasts of bananas. Two types of explant material were evaluated, namely flower shoot tips and the shoot tips of in vitro grown plantlets.

Flower shoot tips, were sectioned through the growing tip and placed with the cut surface in contact with the nutrient medium. When grown on a medium of MT salts with various additives and BA (5 mg/l) these tissues produced a prolific white nodular callus.

This callus was easily subcultured despite numerous adverse reports in the literature regarding the necrotic nature of banana callus after transfer to fresh medium. The callus produced many bulbous and other structures resembling various stages of somatic embryogenesis, but only three plantlets developed in this manner. Owing to some undefined factor, the developmental processes appeared to be arrested and the recalcitrant nature of these structures to develop into plants. This could not be altered by various PGR treatments.

On this same medium, the sterile male flowers arranged around the apex of the flower shoot tip explant developed in culture and could produce large numbers of banana plantlets. This ability to change from a predetermined reproductive nature to a vegetative habit may be used advantageously where limited material is available for micropropagation, as this technique can be employed to rapidly multiply banana material.

On media with 1 or 2 mg/l of either 2,4-D or picloram, shoot tips of in vitro grown plantlets became swollen, but no callus developed. Bulbous, nodular structures occurring on the explants did not develop either, but when placed in liquid culture of the same composition on an orbital shaker, these structures became detached and floated freely in the medium.

Original explant material continued to produce bulbous structures and were thus continuously subcultured. Large numbers of small round structures resembling pro-embryos were produced and became bright green-yellow when cultured in reduced levels of PGR, but could not be induced to develop further on a variety of media.

Cells were also sloughed off from the explant tissue during the rotating liquid phase so that suspension cultures containing large numbers of single cells were also produced. Original explants, embryo-like structures and suspension cultures were all subcultured and maintained separately.

DIVERSE SUBTROPICAL FRUITS

• *Physiology*

SS.2485/03/2/3:

DIVERSE SUBTROPICAL FRUIT: DEVELOPMENT OF TISSUE CULTURE TECHNIQUES FOR THE PRODUCTION OF EMBRYOGENIC CALLUS AND PROTOPLASTS IN MANGOES. 1985-1989

G.W. de Winnaar

This facet comprised the development of a protocol for the initiation of embryogenic callus and protoplasts with a view to in vitro selection for several desirable characteristics, e.g. resistance to bacterial black spot.

Callus was initiated from nucellus tissue of ovules from immature poly-embryonic mango fruit. The callus was maintained on the initiation medium by frequent subculturing and transferred to an embryogenesis medium to obtain somatic embryos. Embryos originating from the callus were allowed to develop on a maturation medium and subsequently incubated on different germination media in order to obtain complete plant regeneration.

After 3-5 weeks in culture, callus had formed from the nucellus of most of the ovules that were incubated on an initiation medium with 6 % sucrose, 400 mg/l glutamine, 100 mg/l ascorbic acid, 20 % coconut milk (CM) and 0,8 % agar. The callus was maintained on this medium for longer than two years.

Transfer of the cultures to an embryogenesis medium (initiation medium without CM), 3 months after callus induction, resulted in extensive somatic embryogenesis. After the 5th monthly subculture, embryogenesis started to decline. Although various treatments were applied to the callus to stimulate the embryogenic response, the formation of somatic embryos could not be induced by the inclusion of growth regulators in the medium. It was concluded that the ability of the callus to form somatic embryos was lost as the cultures grew older. When formation of somatic embryos from the callus is first observed, this process must be exploited by continued transfer of the cultures to the embryogenesis medium, to ensure maximal yield of somatic embryos.

Maturation of embryos was superior on the initiation medium with CM, solidified with 0,2 % Gelrite instead of 0,8 % agar. All the stages of embryo maturation were observed on this medium. Germination was best on a medium with 20 % CM + mg/l 6-benzyl-aminopurine (BA) and was also promoted by the inclusion of 1 or 10 mg/l gibberellic acid (GA₃) in the medium. Both germination of embryos and development of shoots from the embryos were influenced by the gelling agent. In this regard 0,2 % Gelrite again proved better than 0,8 or 1 % agar.

Although a germination rate of 58 % was obtained in the best case and shoots as well as roots developed from the embryos, no plants could be re-established into soil since the shoots had died in culture as a result of phenolic browning. Techniques for the efficient regeneration of plants from callus were thus not finalised and, therefore, work on protoplast cultures did not commence.

• *Upgrading*

SS.2485/07/1/3:

BREEDING AND SELECTION OF DIVERSE SUBTROPICAL FRUIT IN RELATION TO GUAVA. 1970-1990

C.P. Welgemoed

Selection of new guava cultivars was carried out by means of critical selection from seedlings planted at the Friedenheim Research Farm, Nelspruit. The variation obtained in the seedlings was used as a means of selecting improved cultivars to give better stability to an industry based only on 1 cultivar, namely Fan Retief.

More than 20 000 trees were evaluated and from these, promising selections were made. These were then evaluated further in the laboratory over a number of years. Five final selections were made and their physical characteristics (fruit mass, fruit length and breadth, thickness of the fruit flesh, and fruit colour) as well as their chemical characteristics (acidity, soluble solids and ascorbic acid) were determined over a three-year period. With the exception of ascorbic acid all other characteristics were better in the selections than in Fan Retief.

Application has been made to register these 5 selections as new cultivars. If this application is approved the cultivars will become available to the quava industry. This will offer an improvement to the present situation as these selections are ideal for both the fresh market and for processing.

● *Pests*

SS.2485/20/1/1:

THE OCCURRENCE AND CONTROL OF KNOWN AND NEW PESTS ON DIVERSE
SUBTROPICAL FRUITS. 1972-1990
E.A. de Villiers

The aim of this facet was to collect all pests or potential pests on miscellaneous subtropical crops, to identify them, study their behaviour and, if necessary, to find control measures and publish the results. Pests such as insects, mites, nematodes and slugs were collected in all the production areas and were sent to the National Collection of Insects in Pretoria for identification.

A summary of the number of pests found, is presented in Table 1. The number of economically important pests are given in brackets followed by the number of registered chemicals to control them.

The most important pests can now be controlled by one or more registered chemicals. Integrated control is emphasised and the use of wide spectrum pesticides discouraged. For example, it was shown that two fenvalerate or two monocrotophos sprays on mangoes resulted in an increase in the mango scale population.

On mangoes the mango weevil is still one of the most important pests, and an application for the registration of fenthion for it's control has been submitted.

On granadillas the importance of the green vegetable bug, *Nezara viridula*, has increased owing to the ability of this pest to transmit viral diseases. This aspect will be investigated further in a new facet.

Nematodes on granadillas are of major importance, especially *Meliodogyne* spp., and the registration of a nematocide on established granadillas will be a great advantage to the granadilla farmer. Preliminary investigations in this direction have been concluded.

Good results have been obtained with a chitin synthesis inhibitor, viz triflumuron, for the control of the litchi moth on litchis. Pending residue analysis, this product will be submitted for registration.

The information gathered from this facet has been presented to the respective industries.

TABLE 1 - Number of insect, mite, nematode and slug pests found on various subtropical crops

Crop	Insects	Mites	Nematodes	Slugs
Granadilla	17 (3) 2	3 (0) 1	7 (4) 0	-
Guava	18 (4) 4	-	6 (1) 1	-
Litchi	7 (3) 2	-	3 (2) 1 -	-
Mango	23 (6) 7	1 (1) 1	19 (10) 1	-
Papaya	5 (0) 1	2 (0) 0	6 (5) 1	-
Banana	11 (3) 7	5 (1) 4	17 (11) 2	1 (1) 3

Nut crops

NUTS

● *Pests*

SS.2491/20/1/1:

THE OCCURRENCE AND CONTROL OF PESTS ON NUT CROPS. 1972-1990
E.A. de Villiers

The aim of this facet was to collect all pests or potential pests on macadamia and pecan nuts, to identify them, study their behaviour and if necessary, to find control measures and make the results available to the industry. Until 1980 this facet also included coffee, tea, spices and medicinal plants. The results on these crops are presented in Table 1.

Pests were collected in all the production areas and were sent to the National Collection of Insects in Pretoria, for identification.

The number of economical important pests are given in brackets followed by the number of registered chemicals to control them.

The most important pests of pecan and macadamia nuts, can be controlled with registered chemicals.

On macadamias, stinkbugs are still a major problem and the use of a wide spectrum insecticide, viz cypermethrin, is believed to cause pest repercussions. This is because of the increasing number of bug species found in macadamia orchards and the occasional outbreak of latania scale and mealybugs.

A new facet has been registered in which the integrated control of stinkbugs on macadamias will be investigated. The aim will be to find alternative pesticides, wich can be used in an integrated control programme.

On pecan nuts, the yellow aphid is considered to be the most important pest. Two insecticides have been registered against this pest, namely pirimicarb, which can be sprayed on the trees and aldicarb which can be applied in the soil under the tree canopy, especially for trees too big to be sprayed with conventional spray machines.

With regard to the pecan stem borer and bark borer, various insecticides were tested and found effective in controlling them.

Whatever the pest, integrated control is emphasised and the use of wide spectrum pesticides discouraged.

The information gathered from this facet has been presented to the respective industries.

TABLE 1-Number of insect, mite and nematode pests found on nuts, coffee, tea, spices and medicinal plants

Crop	Insects	Mites	Nematodes
Pecan	9 (4) 2	-	8 (1) 1
Macadamia	22 (9) 2	-	-
Bixa	-	-	3 (0) 0
Turmeric	-	-	1 (1) 5
Digitalis	3 (0) 0	-	-
Ginger	6 (2) 3	-	4 (4) 6
Hibiscus-tea	1 (1) 0	-	-
Coffee	12 (6) 7	-	-
Geraenium	2 (1) 0	-	-
(<i>Pelargonium graveolens</i>)			
Tea	2 (0) 0	6 (2) 1	5 (0) 0

*Where 9 = number of pests, (4) = important pests and 2 = registered chemicals

● Crop science

SS.2491/30/3/2:

TREE RESPONSE TO PRUNING AND MANIPULATION OF NUT TREES: MACADAMIA NUT TREES. 1987-1990

E.M. Widd

The objective of this facet was to determine the growth response of macadamia trees to pruning at three different times, and to control the volume of mature trees by pruning and growth manipulation.

The conclusions made from this observation trial are that large adult trees can definitely be pruned, new growth must be manipulated to reduce vigour, and pruned trees become healthier and more vigorous than unpruned trees.

There is also a negative response in the sense that trees which are pruned, take too long to come into production again and give poor yields for at least three seasons after pruning. Pruning is also labour-intensive and there is much follow-up pruning to be done after the main pruning. There were no differences in the growth responses of the trees between summer, autumn or winter pruning.

The proposal for a new facet is that only trees of *Macadamia integrifolia* should be used. A further proposal is that the main method of pruning used should be the pyramid system which has been previously tested. The hedgerow pruning method should also be tested since this is an industry request.

Growth regulators should be used not only to manipulate new vegetative growth on pruned trees but also to control the vigorous vegetative regrowth where the pruning cut was made. A quantitative method of crop forecasting must be used to determine total yields, whereas nut quality should also be determined. The new facet should have replicated and randomised treatments which can be analysed statistically.

This facet has now provided enough indication of responses to pruning at different times to enable a new facet to be initiated. This facet is, therefore, terminated.

Sundry horticultural crops

HORTICULTURAL CROPS

● Nutrition

VV.24111/05/3/1:

HORTICULTURAL CROPS: SEASONAL UPTAKE OF NUTRIENT ELEMENTS BY KIWI FRUIT. 1983-1990

J.F. de Villiers

Hayward kiwi fruit grafted onto seedling rootstock were planted in acid-washed sand in 100-ℓ plastic containers and kept out of doors. The vines were fed twice weekly with 2 litre Hoagland's standard solution.

During the third growing season the vines were sampled 13 times from the end of September to the beginning of August. Vines were separated into roots, wood (rootstock, trunk and older shoots), bark on wood, new shoots, bark on new shoots, leaves and fruit. Samples were dried, the mass determined, and milled to pass through a 20-mesh screen. A subsample was ground in a sintered alumina ball mill and analysed for total nutrient element content. In a separate study the seasonal periodicity of root activity of kiwi fruit vines were investigated in sand culture with nutrient solutions labelled with ^{15}N , ^{32}P and ^{65}Zn .

The total dry mass of the kiwi fruit vine increased sharply from bud break (October 10) until the beginning of March. The largest increases took place in above-ground new growth (47 %), whereas root mass increased by 33 %. The contribution of roots to the total dry mass decreased from 60 % during dormancy to 40 % at harvest. From dormancy to 3 weeks after flowering there was a tendency for dry mass of roots, wood and bark to decrease, which might have been due to utilisation of carbohydrate reserves by the developing vine. This decrease in dry mass was less pronounced than had been reported for other deciduous fruit trees and grapevines.

There were indications that especially nitrogen, and to a lesser extent potassium, reserves from roots and bark could play an important part in the development of the vine shortly after bud break. During a 4 to 7-week period prior to harvest, potassium was translocated from leaves, bark and wood to fruit. Since the fruit is such a strong sink for potassium, application of sufficient potassium fertiliser in spring is essential to ensure optimal growth and production. The kiwi fruit vine has a high calcium requirement and 50 % of the calcium taken up during the season was translocated to leaves. The root system constitutes an important organ for reserve nutrients. Although roots made up only 60 % of the total mass of the vine during dormancy, they contained 75-84 % of the total macro-nutrient content of the vine at that stage.

The period of rapid accumulation of different micro-nutrients differed substantially. Zinc and copper were accumulated over a 12-week period after bud break, manganese and boron over a 17-week period and iron over a 20-week period. There was no indication of translocation of micro-nutrients from leaves to fruit before harvest, reflecting the lower mobility of these elements in the plant and lower demand by the developing fruit. It was, furthermore, confirmed that zinc is probably not highly mobile in kiwi fruit vines, although the opposite has been suggested in the past. The largest amounts of manganese, iron and boron were accumulated in leaves, whereas the largest amounts of zinc and copper were found in roots. With the exception of boron, fruit was relatively unimportant sink for micro-nutrients. Substantial amounts of manganese, zinc and iron were lost from leaves after harvest, before leaf drop. There were some indications of increased content of these nutrients in the permanent parts of the vine and at least some of these nutrients might have been transported out of leaves before senescence. However, no indication was found in the present study of translocation of micro-nutrients from the permanent part of the vine to new growth during the early part of the growing season. In general, the kiwi fruit vine has a low requirement for micro-nutrients.

Seasonal accumulation of nutrients by the kiwi fruit vine has important implications in relation to the timing of fertiliser application. Recent studies have shown that kiwi fruit requires large quantities of potassium and to a lesser extent nitrogen. Fertilisers containing these nutrients need to be applied before fruit set if deficiencies were to be avoided. However, the present results indicate that, owing to the fact that potassium and nitrogen are transported from leaves to fruit before harvest, a deficiency might still develop in leaves before harvest even though the vine might be well supplied with these nutrients. The need for re-allocation of potassium in the above-ground part of the vine appear to be related to problems with translocation of potassium to the above-ground parts, which, in turn, may be related to water use efficiency.

Limited translocation of P and Zn to the above ground parts were observed and use of these tracers in the field may yield erroneous results. High absorption rates of both P and N into roots were observed throughout the observation period from before bud break until after leaf drop. Very high rates of Zn absorption was observed during the later half of the season. High root activity by kiwi fruit vines in autumn was indicated.

• Crop science

GS.24/11/30/1/1:

CHEMICAL WEED CONTROL STUDIES WITH THE HORTICULTURAL CROP: GUAYULE.
1981-1990

H.A. Dafel

The aim of these trials was to evaluate potential herbicides for the use of guayule plants with the emphasis on transplanted seedlings.

Fourteen herbicides were evaluated under field conditions. Of the herbicides tested butylate, propyzamide, oxyfluorfen, trifluralin and alachlor all appeared safe for use on guayule. There may, however, be many other herbicides though not screened in this trial that could also be suitable for weed control in guayule. Of the potentially useful herbicides tested oxyfluorfen was again evaluated at various dosages and times of application in relation to the crop. From visual observations no adverse effects could be found in any of the treatments.

The facet clearly shows that if guayule is ever to be grown commercially, effective weed control using the available herbicides should not be a limiting factor in the production cycle.

GS.24/11/30/2/1:

CULTIVATION STUDIES WITH THE HORTICULTURAL CROP: GUAYULE. 1981-1990
H.A. Dafei

The aim of these trials was to evaluate the effects of certain cultural practices when establishing bare-rooted transplants on the eventual yield of guayule.

It is now evident that the planting of older bare-rooted transplants holds absolutely no advantages. The best time in which the transplants are to be planted seems to vary between the cultivars tested. On the average the early summer planting appeared to be the most suitable time to establish guayule.

If guayule is to be considered as a commercially viable crop similar trials will have to be established using the more vigorous growing cultivar A101. Seedling growing systems and direct seeding should also be investigated.

PLANT PROTECTION RESEARCH

Entomology/Zoology

INSECTS

• Pests

PB.2511/20/2/3:

EVALUATION OF INSECTICIDES FOR USE IN BAITS AGAINST THE HARVESTER TERMITE. 1985-1990
Francis D. Duncan

During the last widespread outbreak of the harvester termite, *Hodotermes mossambicus*, in South Africa between 1980 and 1984, conflicting reports were received on the effectiveness of several commercial baits. This suggested the need to re-evaluate these compounds in field and laboratory trials.

Field trials conducted at Bothaville, Pretoria, Viljoenskroon and Potchefstroom with two commercial baits, one containing 3,6 g carbaryl/kg and the other 75 g sodium fluosilicate/kg, indicated that both baits had only a limited effect on harvester termite populations and were unlikely to control a population build-up during outbreak periods. These baits were subsequently withdrawn from use.

Laboratory studies showed carbaryl and sodium fluosilicate were effective chemicals for the control of harvester termites but that the composition and size of the bait pellets in which these chemicals were incorporated was unattractive to the termite. It was concluded that for efficient baiting, the bait pellets should be made from natural grass to a size that would be readily collected by foraging termites.

A laboratory comparison of the degree of control given by grass pieces treated with 3,6 g carbaryl/kg grass, a commercial bait containing 3,6 g carbaryl/kg and two other commercial baits each containing 16 g carbaryl/kg, showed that only the carbaryl-treated grass killed the test colonies within 30 days. Increasing the concentration of carbaryl in the bait failed to make the bait more efficient but using a carrier more acceptable to harvester termites did.

PB.2511/20/2/6:

FOOD PREFERENCE OF HARVESTER TERMITES AND POSSIBLE BAIT IMPROVEMENT. 1987-1990
Francis D. Duncan

In South Africa the harvester termite, *Hodotermes mossambicus*, competes with livestock for grazing, particularly in winter, and is therefore regarded as a pest of economic significance. Poison baiting is the chemical control measure commonly recommended and the two insecticides most often used are carbaryl and sodium fluosilicate. The efficacy of two commercial baits, one containing 3,6 g carbaryl/kg and another 75 g sodium fluosilicate/kg, was tested in the field in the north-western Orange Free State and the south-western Transvaal. Monthly counts of the numbers of foraging holes were used as an index of termite population density. These counts showed that the two baits were ineffective for harvester termite control. The number of foraging holes on the untreated plots declined during the period of study indicating that the termite populations were affected by other factors, possibly the prolonged drought.

Field observations not only showed that the termites collected the bait pellets erratically but that about 10 % of the pellets were collected. The mean survival times of laboratory colonies offered one of the baits as the only source of food did not differ significantly from that of starved colonies.

Field and laboratory observations showed that termite workers did not have a marked preference for a particular grass species. All the dominant grass species were collected.

The mass and size of the plant material collected by worker termites was independent of their size. However, neither the mass, length or width of the commercial bait pellets tested, fell within the mass or size range of the plant material collected by harvester termites.

When chopped dry *Aristida* spp. grass was used as a carrier for carbaryl or sodium fluosilicate and the concentration of the chemical/kg grass was the same as that of the respective bait formulations, the mean survival times of colonies fed the grass baits indicated that carbaryl-treated grass was the most effective, whereas the sodium fluosilicate-treated grass was the most attractive.

A field investigation on the foraging behaviour of the workers showed that the minor workers were primarily responsible for transporting plant material and the major workers were primarily responsible for cutting plant material.

To effectively kill *H. mossambicus* using a bait formulation bait pellets must be of a size that are easily transported by minor workers and intermediate larvae, and the poison should be slow-acting so that it can spread throughout the colony before the large larvae die.

HONEY-BEES

• *Upgrading*

PB.2516/07/1/1:

THE SELECTION OF IMPROVED LINES OF HONEY-BEES. 1981-1989

R.H. Anderson

In 1975 a small-scale breeding programme with the African bee was initiated on Robben Island to improve this race for the industry. An inbred-hybrid system was adopted with three lines, "Karoo", "Kalahari" and "Transvaal". Each line consisted of two 12 colonies each. One queen was selected annually from each line to supply young queens for the following generation.

Natural line mating was used during which drones in two of the lines were confined to the hives with drone traps. The colonies were inspected monthly and selection was based on a five-character index. Tenth generation "Karoo x Kalahari" hybrids (21 colonies), were commercially tested for a season in Transvaal migratory beekeeping against 21 local colonies. The two groups performed equally well, although honey production and brood viability was higher in the local stock. Queen survival, resistance against swarming and temperament were better in the hybrids.

A series of experiments were also carried out to determine the degree of misorientation of young queens returning to their hives after the mating flight. The results showed that hive position and bicolour broken patterns are the most important orientation clues for returning young queens.

In 1983 a selection programme for the improvement of the Cape honey bee was started with six lines of 10 colonies each. The colonies were re-queened annually with young queens in the sealed cell stage. Selection parameters were honey production, non-aggressiveness, general behaviour, disease resistance and brood pattern. Losses through vandalism, non-emergence from queen-cells, killing by worker bees, loss on mating flights and loss through supersedure finally hampered the work to such an extent that the project was discontinued.

Attention was also given to queen rearing techniques for the Cape honey bee. Although the large scale production of queen cells is possible in this race, it involves special techniques and equipment. This study endeavoured to develop techniques for rearing queens throughout the year without hive modifications. Grafted queen cell cups were used in colonies with caged queens, the latter which were kept in an incubator for one night only, after dequeening.

There was very little difference in the number of initially-accepted cells and cells sealed subsequently. The success rate in the upper and lower bars of the rearing frame also did not differ. Fewer queens were reared in the winter. Great variation in success with different colonies occurred, probably because of genetic differences and the laying worker factor.

• *Behavioural studies*

PB.2516/28/1/1:

THE BEHAVIOUR OF HONEY-BEES IN APPLE ORCHARDS. 1985-1989

R.H. Anderson.

The basic pollination process is described and research was undertaken to solve pollination problems.

A survey was made of insects visiting pear tree flowers during pollination. The great variation in numbers of honey bees, other bees, wasps, drone flies, and other flies precluded generalisations of the abundance to be expected.

The average time that apple flowers were open to bee visits was 85 hours. Flowers were visited about 3 times per hour. Bees tended to collect more nectar than pollen before noon, and vice versa afterwards. The ratio of nectar to pollen collectors accordingly varied from 11,5-1, and 6,25-1. A single nectar collector visited 9,4 flowers, and a pollen collector 6,0 flowers per minute.

Pollination by one bee visit to a flower resulted in a 6,6 % fruit set and 6,29 seeds per fruit. When the bee's visit was categorised according to nectar or pollen collection and type of approach, one visit by a pollen collector resulted in a high set equivalent to open pollination. Flowers that set fruit had been exposed to an average of 68 bee visits. The number of flowers in a cluster was not related to the attractiveness of the cluster to bees.

Bees tended to work along rows of trees rather than across rows. The implications for polliniser distribution in orchards are indicated. Fruit set was significantly related to distance from the polliniser. Fruit set on the near side of trees to the polliniser was also significantly higher. Wind played an insignificant role in fruit set.

Fruit set was not significantly affected when pollination was limited to the latter half of the flowering period.

A commercial bee attractant was evaluated for its effectiveness in promoting pollination by bees. Bee visits to flowers were not increased, but some benefit in fruit set was demonstrated. In an attempt to increase pollen collection by bees to promote pollination, bee colonies were intermittently deprived of pollen stores. Bees could be successfully induced to collect more pollen, the effect lasting up to three or four days.

Recommendations for pollination management are offered to fruit growers and beekeepers.

FOREST AND TIMBER

● Pests

PB.2519/20/1/5: THE BIOLOGY AND BEHAVIOUR OF THE NATURAL ENEMIES OF PINE APHIDS.
1984-1989
J.F. Kirsten.

The biology of the aphidiid parasite, *Pauesia* sp., was studied to determine the likelihood of successful adaptation of the parasite in southern African pine forests. The parasite had previously, under another facet, been introduced from the United States of America for the control of the black pine aphid, *Cinara cronartii* T & P.

The *Pauesia* sp. was found to be specific to the black pine aphid, *Cinara cronartii*, in southern Africa. The calculated threshold of development of the parasite is 6,17 °C and the observed upper threshold is about 29 °C. The thermal constant is 217,39 days. Scanning electron microscope micrographs showed that *Pauesia* sp. has four larval instars. The developmental time from oviposition to prepupal stage was 8,7 days at 21 °C. Mummification occurred at the end of the third instar on the seventh day. The development of the host is not affected until the parasite has completed about 40 % of its development. The aphid is, therefore, capable of producing progeny providing that parasitisation occurs on or after the third nymphal instar. On average 8 to 13 progeny can be produced by apterae parasitised as nymphs, depending on time of oviposition.

Pauesia sp. appears to be sensitive to relative humidities lower than 40 % at temperatures above 20 °C.

Ovisorption occurred when females were deprived of oviposition opportunities or contact with their host. The parasite is an arrhenotokous synovigenic species with the females only copulating once. The egg distribution of the parasite within an aphid colony follows the Poisson distribution indicating that the parasite searched at random after a colony had been located. Aphids parasitised by newly emerged mated females showed a higher percentage of superparasitism than older females. Although superparasitism was found to be common only one larva was found to develop to the adult stage. The disappearance of the supernumeraries can either be caused by cannibalism or physiological suppression.

The study confirmed that *Pauesia* sp. should be able to adapt to all climatic regions in southern Africa where the black pine aphid occurs.

PB.2519/20/1/9: THE ECOLOGY AND CONTROL OF FUNGUS GROWING TERMITES IN FORESTRY PLANTATIONS. 1984-1990
P.R. Atkinson

Work has been mainly confined to the development of solutions to insect- and nematode-related problems in the establishment of Eucalyptus. The foremost problem in 1984, when work started, was termite damage caused by fungus-growing termites, particularly *Macrotermes* species.

A series of trials was planted to assess insecticides other than chlorinated hydrocarbons for termite control. Chlordane was used as the standard for comparison. Detailed results of these trials over four years

has been reported elsewhere (Atkinson, 1989). Briefly, controlled-release granules with a two-year release period, containing the active ingredients carbosulfan or carbofuran, applied at 1,0 g a. i./tree at planting, offer a reasonably effective substitute for chlorinated hydrocarbons. Controlled-release granules containing phorate were unreliable in very dry soil conditions, whereas those with chlorpyrifos were ineffective. There was no advantage in using granules with a shorter release period, in order to increase the amount of active ingredient in the soil per unit time; nor in using smaller diameter granules than the standard 1,5-2,0 mm, in order to increase the number of contact points per unit mass of product applied to the seedlings. A probable alternative to the controlled-release granules is alphemethrin suspension concentrate, at 0,1 g a.i./tree, but the emulsifiable concentrate was ineffective, as were seven other soil insecticides.

Trials were also planted testing the susceptibility of 33 eucalypt species and 32 clones to termite attack. The results are reported elsewhere (Atkinson *et al.*, in press). *E. dunnii* and *E. macarthurii* were highly resistant. Resistant, or moderately resistant, species tended to belong to the subgenus *Symphomyrtus*, section *Maidenaria*, series *Viminales*, which may help to identify material for the selection of species resistant to termites, or even perhaps other root-feeding insects, elsewhere. Clones, even hybrid clones crossed with the resistant *E. macarthurii*, tended to be susceptible to attack.

The design and analysis of field trials to test treatments against soil pests has not apparently been covered in the literature to the same extent as have designs for fertiliser and other crop treatments. Therefore, some time was spent in testing different designs and methods of analysis for the trials reported above (Clarke & Atkinson, in preparation).

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Plant pathology/Microbiology

FUNGI

• Pathology

PB.2521/19/6/1:

EPIDEMIOLOGY OF DISEASES CAUSED BY FUNGI OF THE GENUS *RHIZOCTONIA*.
1987-1990

A.J.L. Phillips

The original aims of this work were to determine the range of crops affected, the relationship between inoculum density and disease incidence, and to develop a method for enumerating the pathogen in soil.

During the three years of this study, 143 isolates of *R. solani* were collected. Most of these were from *Phaseolus vulgaris* but other hosts included *Glycine max*, *Gossypium hirsutum*, *Lupinus* spp., *Lycopersicon esculentum*, *Nicotiana tabacum*, *Pisum sativum*, and *Solanum tuberosum*. The diseases were mainly pre-emergence seed decay and post-emergence hypocotyl and epicotyl rots. A leaf spot disease of tobacco occurred in 1987/88 but it is unlikely that this disease is of any major importance in South Africa.

The relationship between inoculum density and disease incidence was studied in 10 isolates of *R. solani* on *P. vulgaris*. The effect of inoculum density on pre-emergence mortality was described adequately by linear regression, whereas its effect on post-emergence hypocotyl rot followed a limiting sites model. Saprophytic colonisation and pre-emergence infections arose from propagules in the spermosphere, whereas depending on the isolate, infection of hypocotyls was from propagules in the rhizosphere or rhizoplane.

Large variations in virulence were found among 30 isolates of *R. solani* when tested on dry beans, soybeans and maize. In addition, there was considerable variation among isolates from within a field but variability within isolates was small. Out of 30 isolates, 12 were classed as highly virulent to dry beans and soybeans, whereas the others were of low virulence and none was intermediate. Soybeans were highly susceptible to both pre- and post-emergence disease and the potential exists for severe epidemics.

Populations of *R. solani* in soil were enumerated by baiting with autoclaved beet seeds. However, because of the variations in virulence among isolates of the pathogen, a better method to determine disease potential is to bait the soil with a host plant.

The aim of this work was to determine suitable measures for the control of *Rhizoctonia* diseases. Measures investigated were biological control and fungicidal seed treatments. *Phaseolus vulgaris* and *R. solani* AG 4 were used as a model system.

An isolate of *Trichoderma aureoviride* antagonised the growth of *R. solani* in agar cultures, colonised cultures of the pathogen and colonised crop residues. In greenhouse trials, applications of *T. aureoviride* to *R. solani*-infested soil reduced the amount of seedling disease. When applied together with crop residues, *T. aureoviride* prevented the increase in disease normally associated with the incorporation of such crop residues.

In greenhouse and field experiments, thiram, quintozene, benomyl and tolclofos-methyl reduced pre-emergence mortality and hypocotyl disease severity of *P. vulgaris* seedlings. Only quintozene and tolclofos-methyl significantly reduced the percentage of hypocotyls infected.

Infusion of seeds with an acetone solution of tolclofos-methyl was an effective and efficient method for treating seeds for the control of diseases caused by *R. solani*.

The incidence of *Fusarium* spp. in soil and on annual *Medicago* (medic) and wheat plants in different crop rotation systems was determined. Sixteen *Fusarium* spp. were isolated from medic soil, 12 from wheat soil, 11 from medic plants, 11 from medic seeds and seedpods and 12 from wheat plants. *F. oxysporum* was the predominant species isolated from soil and from roots and crowns of both medic and wheat plants.

F. acuminatum was the predominant species isolated from medic seeds and seedpods. Several rare and newly recorded *Fusarium* spp., such as *F. tricinctum* and an undescribed *Fusarium* sp. were also recovered. The cultural characteristics and morphology of the isolates of *F. tricinctum* were identical to foreign reference cultures, and pathogenicity of *F. tricinctum* to *M. truncatula* was shown for the first time. The unidentified *Fusarium* sp. which resembles *F. camptoceras*, but differs in several respects, was phytotoxic rather than pathogenic to medic and wheat plants and was shown to produce the trichothecene neosolaniol monoacetate.

Seasonal variation occurred in the incidence of *Fusarium* spp. in soils and medic seeds and seedpods. *F. graminearum* Gr. 1 and *F. avenaceum*. The most important *Fusarium* pathogens of wheat and medics, respectively, in South Africa were isolated from soil more frequently during than at the beginning of the growing season. However, *F. avenaceum* occurred more commonly at the beginning than at the end of the growing season, on medic seeds and seedpods at one location.

Differences in the incidence of *Fusarium* spp. in the different rotation systems were reported. The incidence of *Fusarium* spp. in soils from the wheat-fallow system was significantly lower than from the other systems. *F. avenaceum* was isolated more frequently from soil, plants, seeds and seedpods in rotation systems with a long continuous than with a short medic period. Crop rotation has an effect on the incidence of *Fusarium* spp. in soils and plants and is, therefore, important in disease control strategies.

In addition to crop rotation, the use of resistant medic and wheat cultivars and seed treatment with fungicides showed potential as control measure against seedling, as well as root and crown diseases caused by *F. avenaceum* and *F. graminearum* Gr. 1. *M. polymorpha* cv. Serena was the most resistant and *M. rugosa* cv. Paraponto the most susceptible medic cultivar. The wheat cultivars tested (Gamtoos, Palmiet, SST 25, SST 33 and SST 66) did not differ significantly in their resistance. Seed treatment with thiram (medics) and carboxin/thiram (wheat), improved seedling emergence and decreased root and crown diseases of most cultivars tested. Tolerant cultivars and seed treatment with the fungicides thiram and carboxin/thiram should, therefore, be included in integrated control programmes against damping-off and root and crown rot of medics and wheat caused by *F. avenaceum* and *F. graminearum* Gr. 1.

BACTERIA

• Nitrogen fixation

The reliability of antibiotic resistance and colony morphology of clones of a *Bradyrhizobium* sp. (*Lotus*) strain for identification in nodulation competitiveness experiments in soil, was investigated. There was no

difference in nodulation competitiveness of the wild type strain and each of five mutants was resistant to streptomycin and spectinomycin at the time of their isolation from antibiotic containing media. These mutants were significantly less competitive when tested four months later.

The apparent instability of the newly isolated mutants and their subsequent decreased nodulation competitiveness, indicates the necessity for careful scrutiny of mutants after they had time to stabilise. Two clones of the *Bradyrhizobium* sp. (*Lotus*) strain which differed in colony morphology on yeast mannitol medium did not differ in either their antigenic properties, whole cell protein electrophoresis profiles, mean cell generation times in YM medium, nitrogen fixing ability, nodulation of *Lotus pedunculatus* in growth pouches or in their nodulation competitiveness.

They retained their colony morphology after numerous transfers on YM agar over three years and after at least six months in soil. A limiting factor which may restrict the use of colony morphology as a marker for strain identification in competition experiments, is the problem of detecting double-infected nodules when the small colony type comprises a relatively small portion of the total nodule population.

• Biological control

PB.2522/22/1/7:

BACTERIA: BIOLOGICAL CONTROL OF CROWN GALL - DEVELOPEMENT OF AGROCIN PRODUCING STRAINS OF *AGROBACTERIUM TUMEFACIENS*. 1987-1990

E.E. de Bruyn

The objective of this study was to obtain a biological control strain for crown gall caused by the narrow host range biotype 3 strains of *Agrobacterium tumefaciens* and to determine the origin of the relatively large numbers of non-pathogenic agrobacteria present in gall tissue (Staphorst *et al.*, 1985; Panagopoulos *et al.*, 1973). Isolations were made from galls and wound tissue of plants inoculated under controlled conditions with biotype 1, 2 and 3 strains of *A. tumefaciens*. Non-pathogenic isolates were partially characterised and compared with the strain used for inoculation.

Non-pathogenic mutants of agrocin producing pathogenic biotype 3 strains of *Agrobacterium* were isolated from wound and gall tissue of various host plants that were inoculated with the pathogenic wild type strain. Loss of pathogenicity in the isolates consistently correlated with a loss in ability to utilise octopine as sole source of carbon and nitrogen. The non-pathogenic mutants differed from the wild type strains and pathogenic isolates in their plasmid profiles. Examination of plasmid profiles showed that homology existed between the largest of three plasmids in the wild type strain H8 and the smallest of three plasmids in the non-pathogenic isolates of strain H8. By using appropriate nucleic acid probes these two plasmids were found to be a Ti-plasmid and a defective Ti-plasmid, respectively. According to Hind III restriction enzyme analysis, the defective plasmid in the non-pathogenic mutant of strain H8 lacked part of their Ti-plasmid. Plasmid profiles hybridisation and other properties studied indicated that all non-pathogenic isolates obtained from various plant species had the same mutation.

Although the non-pathogenic mutant of strain H8 retained its agrocin producing ability, this mutant of strain H8 was unsuccessful as biological control agent in preliminary greenhouse experiments. The significance of the consistent presence of non-pathogenic mutants in wound tissue and galls of various plant species inoculated with strain H8, is unknown at this stage. Selective enrichment in plant wound tissue of a non-pathogenic mutant present in cultures of strain H8 that were used for plant inoculations, would be a plausible explanation, but we have so far been unable to isolate non-pathogenic mutants from laboratory cultures.

VIRUSES

• Virology

PB.2523/12/1/3:

DEVELOPMENT OF IMMUNOLOGICAL VIRUS DETECTION PROCEDURES FOR GRAPEVINE DISEASES. 1985-1990

D.J. Engelbrecht

In this project antigens associated with grapevine leafroll (GLR) and associated diseases were isolated, purified and used in the production of pyclonal antisera. Immunological detection procedures were evaluated to replace current unreliable and time-consuming indexing of these diseases on woody indicator vines. Four closteroviruses (CVs) were identified in local GLR-infected vines, including grapevine virus A (GVA), GLR-associated (assoc.) CV Type I, GLR-assoc. CV Type II and GLR-assoc. CV Type III.

GVA was transmitted from a grapevine source by the vine mealybug, *Planococcus ficus* to *Nicotiana clevelandii* from where it was purified by extraction in 0,1 M Na-phosphate, pH 7,5, containing 0,005 M Na-EDTA and 0,02 M N₂SO₃, clarified with chloroform, precipitated with 8 % polyethylene glycol, and

separated by rate-zonal density gradient centrifugation in Cs_2SO_4 . Polyclonal antisera prepared in both goat and rabbit were used in a newly developed indirect double antibody sandwich (DAS) enzyme-linked immunosorbent assay (ELISA) with a peroxidase anti-peroxidase (PAP) complex as probe for the detection of GVA in field-collected grapevine sources. GVA was detected in both dormant and actively-growing shoots up to dilutions of 1:10 000. The PAP-ELISA procedure was found to be most suitable for routine diagnostic work despite the presence of low-level antibodies to GLR-assoc. CV Type III.

Lack of alternative herbaceous hosts and single isolates of grapevine CVs other than GVA required extraction of virus directly from grapevine and separation of CVs in the course of purification. An adaptation of procedures described by Gurgerli *et al.* (1984) which involved extraction in 5 % Triton x-100 and 1 % Driselase, precipitation with 5 % polyethylene glycol and separation by rate-zonal density gradient centrifugation in Cs_2SO_4 were used. Despite increased yield and recovery of intact particles separation of CVs could not be achieved. Antisera prepared to CV particles collected from a narrow band in a Cs_2SO_4 gradient still contained antibodies to a second CV. However, such antisera were used successfully in immunosorbent electron microscopy and antibody coating (decoration) for the identification of CVs in local grapevine sources. In addition, the antisera contained antibodies to an isometric virus-like particle shown to be associated with grapevine fleck disease. Future detection of grapevine fleck disease will be by serological means with the recent discovery of a pure culture of the isometric virus-like particle in grapevine.

Availability of *single* isolates of GLR-assoc. CV Type II and GLR-assoc. CV Type III during the current season has led to the production of high-titre antisera in both goat and rabbit. These antisera are presently under evaluation for use in ELISA screening systems of GLR and associated diseases, grapevine corky bark and grapevine Shiraz decline of which GLR-assoc. CV Type III is an essential component.

PB.2523/12/1/4:

DEVELOPMENT OF NUCLEIC ACID COUPLED VIRUS DETECTION PROCEDURES OF GRAPEVINE DISEASES. 1985-1990

R. Carstens

In this project procedures were evaluated for the isolation, purification and analysis of double-stranded (ds) RNA components present in grapevines infected with graft-transmissible diseases. The dsRNA components were compared with the closteroviruses (CVs) present. Comparisons of the dsRNA extraction procedure showed that the *p*-aminosalicylic acid (PASA) procedure produced sharper dsRNA bands than the sodium dodecyl sulphate (SDS) procedure with leaf and petiole material. However, when the amount of material was reduced from 40 g to 5 g little or no detectable dsRNAs were present even with the PASA procedure.

Studies with phloem bark tissue have shown that the optimal sampling time was during late winter (August-September) when major and minor dsRNA bands could be detected with amounts of material as low as 8 g. The slowest moving dsRNA band detected in *Vitis vinifera* CVO Crouchen appears to be the genomic replicative form (RF) of GLR-assoc. CV Type III. The other slow moving dsRNA multiple band was detected in the same region as the dsRNA extracted from *Nicotiana clevelandii* infected with grapevine virus A (GVA) and assumed to be the RF of GVA with a molecular mass (mol. wt.) of 5.1×10^6 . A further two prominent but faster migrating low mol. wt. dsRNA bands were also observed.

Extraction of dsRNA by procedures of Rezaian & Krake (1987) failed to detect dsRNA in grapevine despite suggestions by these authors that their two-step SDS phenol procedure might replace the standard SDS procedure. Replacing SDS with Na-sarkosyl did not improve extraction of dsRNA from grapevine.

Absence of detectable dsRNA from grapevine fanleaf-infected vines is difficult to explain with the presence of high concentrations of grapevine fanleaf virus in grapevine tissue.

In conclusion the results of this investigation showed that, except for a period of about 6 weeks following bud-break, the dsRNAs of GVA and GLR-assoc. CV type III can be detected in grapevine sources throughout the year. Although not assessed, the patterns of the minor faster moving dsRNA bands might be of value to differentiate mild and severe strains of GLR-assoc. CV Type III for use in mild strain pre-immunisation control studies of GLR, grapevine corky bark and grapevine Shiraz decline diseases. GLR-assoc. CV Type III was found to be an essential component of these diseases.

PB.2523/12/1/5:

DETECTION AND IDENTIFICATION OF SEED-TRANSMITTED VIRUSES IN SOYBEANS. 1985-1990

G. Pietersen

Only two viruses have been reported so far on soybeans in South Africa, whereas numerous viruses have been reported throughout the world. In order to determine the status of viruses of soybeans in South Africa, especially with reference to seed-transmitted viruses, $F(ab')_2$ ELISA systems were developed to detect the following seed-transmitted viruses: AMV, bean pod mottle virus (BPMV), cucumber mosaic virus (CMV), southern bean mosaic virus (SBMV), SoyMV, tobacco ringspot virus (TRSV), and tobacco streak virus (TSV), as well as the following important non-seed-transmitted viruses: bean yellow mosaic virus (BYMV), cowpea chlorotic mottle virus (CCMV), and peanut mottle virus (PeMotV).

These ELISAs were used to test 200 soybean plants collected in Transvaal. Results were confirmed using immunosorbent electron microscopy (ISEM) followed by antibody coating (AC) and mechanical inoculation onto a limited host range.

Twenty-one viral isolates were established, including 15 isolates of SoyMV, one isolate of PeMotV, and five isolates of a virus which did not react in any of the F(ab')₂ ELISA systems. The host range and symptomatology, cytopathology, aphid transmission, particle morphology and length distribution, molecular mass of coat protein, and serology were determined for one isolate each of SoyMV, PeMotV, and the unknown virus. Two new strains of SoyMV were established, as well as a symptom variant of one of the strains.

The PeMotV isolate differed sufficiently from reported strains to be considered a new strain. This is the first report of this virus in South Africa. Some sources of resistance to this isolate in soybeans were identified.

Antiserum raised to one of the unknown viral isolates reacted with the other four unidentified isolates and co-migrated with them in Western blots, suggesting that they are isolates of the same virus. The virus had a particle morphology, and induced cytoplasmic inclusions typical of a group III potyvirus. Aphid transmission could not be demonstrated. The isolate showed serological relationships using IEM with a number of potyviruses. The isolate showed the same relative mobility and reacted with passion fruit woodiness virus (PWV) antiserum in reciprocal western blots. The host range of the isolate, however, differed from that of PWV. The isolate was, therefore, not assigned to a specific virus until definitive comparisons with PWV and the potyviruses reported on soybeans in Taiwan or Indonesia, could be done.

The soybean cultivars used in the National soybean cultivar trials were all tested for resistance to mechanical inoculation by each of the characterised virus isolates SoyMV-86/20 Isolate 87/14 and PeMotV-88/63.

Weed Research

WEEDS

• Ecology

PB.2551/27/1/3:

THE ECOLOGY OF THE WEED *PROSOPIS*. 1988-1990
G.B. Harding

Prosopis species (Fabaceae) introduced to southern Africa as fodder and shade plants, have invaded vast areas of the arid north-western Cape. Invasive species include *P. velutina*, *P. glandulosa* var. *torrevana* and *P. juliflora*, amongst which hybridisation occurs. The Kenhardt-Carnarvon district is the centre of the distribution which covers around 200 000 ha, although some 935 000 ha is threatened.

Distribution is not influenced by soil type, but is affected by soil depth and the presence of ground water. Seeds require acid scarification for germination and are dispersed by wild animals and domestic stock which ingest the pods. Sheep grazing caused between 90-54 % damage to the seeds and may reduce seedling recruitment.

Seeds have a limited life span in the field, particularly when exposed. Seedlings established on all soil types tested, but grew better on soils of a higher clay content. Trees grew larger and denser when rooted in ground water, but did not adversely affect the water table. The plants displayed distinct patterns of stomatal and leaf closure and had a high light compensation point. The timing of herbicidal treatments with plant physiology may improve the efficacy of control.

ANIMAL PRODUCTION PROMOTION

ANIMAL PRODUCTION AND ANIMAL PRODUCTS RESEARCH

Animal production

BEEF CATTLE

• Upgrading

VS.3111/07/1/4:

BEEF CATTLE: THE EFFECTS OF SELECTION FOR GROWTH UNDER DIFFERENT MANAGEMENT SYSTEMS ON PRODUCTION EFFICIENCY. 1985-1990

J. van der Westhuizen

A mixed model analysis was carried out on the data of two unrelated stud beef herds in the Eastern Cape. The animal model was used to obtain breeding values for all animals in the herds. Breeding values of herd sires were compared and their individual contributions to genetic improvement discussed.

The first herd consists of Weebollabolla Shorthorn cattle originally imported from Australia. Other than the original import and the introduction of semen from two "migrant" bulls in 1985 own herd sires were bred. Apart from other criteria selection of replacement bulls is based on growth under farm conditions. The following procedure was used:

1. Inbreeding coefficients were calculated for every animal in the herd. The increase in inbreeding was efficiently controlled by the breeder as the annual average increase is only 0,027.
2. Average breeding values showed a positive trend for weaning and eighteen-month-old masses but breeding values for weaning mass ratio showed no definite change. The contribution of individual bulls to changes in the average breeding values is discussed.
3. The 20 % females born in 1981 and 1982 with the highest breeding values for weaning mass and weaning mass ratio had shorter intercalving periods later in life than the 20 % with the lowest breeding values. In the case of eighteen-month-old mass those with the highest breeding values had the longest intercalving periods.
4. The year effects for weaning mass showed no trend in contrast with weaning mass ratio and eighteen-month mass that showed a negative trend. The curves for weaning mass and weaning mass ratio showed distinct similarities.

The second herd consists of Bonsmara cattle and is a prime example of a multiplier in most of the herd sires used. One of the main selection criteria of these replacements is growth under an intensive feed regime.

1. No definite trends exist for any of the measured traits. The role of individual sires in year averages is discussed.
2. The trend for year effects on birth mass is negative but positive for weaning mass and weaning mass ratio. The average phenotypic values for mass of dam in a specific year as an environmental effect showed no relationship with year effects of birth mass.
3. Yearling of eighteen-month-old masses showed no trend.

Response to selection for traits included in breeding goals depends to a large extent on whether selection is carried out in the environment in which the progeny is to perform.

The buying of outside breeding stock poses a problem if genetic merit must be judged on phenotypic measurements especially when done in another herd. The problem can greatly be resolved with a mixed model analysis on a national level.

VS.3111/07/1/7:

BEEF CATTLE: PREDICTION OF BREEDING VALUES AND QUANTIFICATION OF GENETIC TRENDS USING MIXED MODEL PROCEDURES. 1985-1990

C.Hunlun

The data of 3 714 Bonsmara cattle from the Roodeplaat herd of the Department of Agriculture and Water Supply was analysed with a single trait Animal Model to illustrate the use of mixed model methodology. Traits considered were birth mass, weaning mass and yearling mass. The data described covers the period from 1940-1987.

The preparation and handling of the data prior to the final analysis received ample attention and a fixed effects model for the estimation of the effects of sex and age of dam is discussed.

Heritabilities of the traits, as estimators of the relevant variance components, were collected from published sources. The values used for the analyses were 0,43, 0,31 and 0,47 for the three traits, respectively.

The environmental trends for the three traits, calculated from the estimates of the fixed effects in the model, were positive but low, except for weaning mass which showed an improvement of *ca.* 30 kg. Breeding value predictions were obtained for 3453, 3064 and 2133 animals for the three traits, respectively.

Genetic trends for the herd of 0,050 kg per year, 0,215 kg per year and -0,352 kg per year were obtained for the three respective traits. The different breeding lines within the herd differed in respect of the various genetic trends. The Edelheer line showed a better genetic gain in respect of all three traits in comparison with the Roodebos line. The genetic trends over F generations for the three traits were 0,221 kg per generation, 1,025 kg per generation and -2,723 kg per generation, respectively.

It is concluded that the mixed model analysis of beef cattle data is a superior alternative selection aid to conventional performance testing in spite of certain reservations.

DAIRY CATTLE

• Physiology

VS.3112/03/1/2:

MILK PROLACTIN SURGE BEFORE AND DURING PARTURITION AND PRODUCTION
PARAMETERS IN DAIRY CATTLE. 1983-1989

J.P. van Zyl

An optimised radioimmunoassay was used to determine prolactin concentrations between 10 days pre-partum and three days post-partum in the peripartum secretion and milk of 20 Friesland cows.

The concentration of prolactin in the pre-partum secretion remained almost constant between 10 and two days pre-partum, fluctuating on average between 43 and 62 ng/ml. Thereafter, a rapid increase in the secretion of prolactin occurred, leading to a mean prolactin concentration of 134 ng/ml in the colostrum on the day of calving. Within two days post-partum, the concentration of prolactin in milk declined to basal levels (< 10 ng/ml). The quantity of prolactin present in the udder on the day of calving varied between 0,20 and 2,65 mg, with a mean of 1,39 mg.

The time dependent course of the production and composition of the milk secreted by the cows, as well as the gross efficiency by which nutrients were incorporated into milk, were investigated.

The duration of lactation was an average 285 days or approximately 41 weeks. The lactation peak occurred approximately 7 weeks post-partum, with a mean peak lactation of 36 kg per cow per day. The duration of lactation was shorter for cows reaching their peak of lactation at an earlier stage. Cows pregnant with heifers also reached the peak of lactation sooner. However, differences in total milk yield between cows pregnant with calves of the opposite sex were not significant.

Total yield varied between 3 250 and 10 711 kg with a mean of 6 554 kg, representing daily yields between 14,6 and 35,3 kg and an average daily yield of 22,7 kg per cow.

During the lactation, a mean of 190 kg fat, 214 kg protein and 315 kg lactose were produced, representing 2,96, 3,26 and 4,79 % of fat, protein and lactose, respectively. The calculated mean gross energy value of the milk produced was 0,66 kcal/g or 2,76 MJ/kg.

The gross efficiency by which nutrients were incorporated into milk, changed at two points during the course of lactation. The first change occurred roughly 9 weeks post-partum, probably representing the point where the cow reached positive energy balance. The second change occurred approximately 26 weeks post-partum, and probably represents the stage where the growing feto-placental unit takes priority in the internal allocation of nutrients at the expense of the production of milk by the udder. During the first period (0-9 weeks), the gross efficiency of incorporation of nutrients into milk was 1,40 declining to 1,18 during the second period.

Relationships between the concentration of prolactin in peripartum secretions, the quantity of prolactin secreted pre-partum, the pattern of secretion of prolactin peripartum and production related traits during the ensuing lactation were investigated.

The quantity of prolactin in the udder at calving was significantly correlated during different stages of lactation with the yield of milk, lactose and protein, the percentage of protein and fat, the gross energy content of milk and the gross efficiency of milk production. Between 21 and 34 % of the variation in these characteristics could be related to the amount of prolactin present in pre-partum secretion.

Neither the concentration of prolactin present in either pre-partum secretion (10-1 days pre-partum) or colostrum (1-2 days post-partum), nor the pattern of secretion during the peripartum period was related to any production traits. However, the concentration of prolactin in udder secretion at partum could be correlated with the percentage of fat and protein and the gross energy content of the milk secreted between the 9th and 27th week of lactation, as well as with the percentage of fat and gross energy content of milk secreted up to the 26th week of lactation.

The use of alternative standards to compare milk yields on an isoenergetic basis was examined. Since animals in certain cases ranked differently by 4 % FCM than the actual energy content of their milk merited, 4 % FCM as a criterion for energy content of milk should be critically re-evaluated using larger sets of data.

The records kept by the National Dairy Animal Performance and Progeny Testing Scheme did not differ significantly from the actual values obtained in this investigation.

PELT SHEEP

• *Reproduction*

VS.3115/04/1/1:

THE REPRODUCTION PHYSIOLOGY OF INDIGENOUS AND EXOTIC MALE ANIMALS IN SOUTH AFRICA: THE EFFECT OF FREEZING KARAKUL RAM SEMEN ON THE SUBSEQUENT FERTILITY OF THE SPERMATOZOA. 1971-1989

J.P.C. Greyling

Experiments were carried out to test different diluents, cooling rates, freezing techniques (pellets and straws) and thawing procedures on the efficiency of sheep semen freezing. The survival rate (percentage live sperm) post-thawing obtained, averaged 35 %, with a low motility score. The survival rate decreased drastically following incubation of up to 6 hours at 37 °C. Research has shown little or no correlation between post-thawing motility and the actual fertilising capacity of the sperm.

An unacceptably low average conception rate of 19,7 % was achieved with frozen semen pellets by cervical insemination. Intra-uterine inseminations by laparoscopy increased the conception rate with frozen semen significantly (mean 42,9 %), but still not satisfactory. Although the technique of intra-uterine insemination results in a higher fertility rate, it does not solve the problems associated with efficient semen freezing.

The French technique (straws) of sheep semen freezing (55 % conception rate with cervical inseminations) was implemented at the Institute, but no fertility results are as yet available. Important factors emerging from the study tour to France include the role played by sperm density in the semen aliquot for efficient semen freezing, the freezing of semen collected only during the active breeding season and the selection of rams according to their semen freezability. The inefficiency of synchronisation is not a contributing factor to the unsatisfactory conception rates obtained with frozen semen.

It is recommended that this long-term facet be terminated and it is also suggested that this important research be continued in the form of short, more subject-specific facets that address the aim of efficient semen freezing more directly and the morphological and physiological effects of freezing on the sperm cell.

MEAT GOATS

• *Reproduction*

VS.3117/04/1/1:

THE REPRODUCTIVE PHYSIOLOGY OF INDIGENOUS AND EXOTIC MALE ANIMALS IN SOUTH AFRICA: FREEZING OF BOER GOAT SEMEN. 1974-1989

J.P.C. Greyling

Despite years of technique development, disappointing conception rates are still obtained following either cervical or intra-uterine inseminations with frozen semen (30 and 50 %, respectively). The results obtained in this investigation have shown that the post-thawing motility of sperm diluted with various diluents varied between 40 and 50 %, whereas the survival rate drastically decreased following incubation for 3 hours at 37 °C (5-10 % live sperm). The washing of goat semen to remove seminal fluid prior to freezing was advantageous in terms of post-thaw sperm survival and motility. The eventual success of freezing Boer Goat semen was found to be influenced mainly by sperm density in the semen aliquot.

The French technique of freezing semen in straws was adopted after a study tour to France by the officer responsible for this facet, but the practicality of this method in the freezing of Boer Goat semen has not yet been evaluated. The technique, however, warrants further investigation, as the mean conception rate obtained after cervical inseminations using semen that had been frozen in straws is 55 % in France. The fact that 82 % conception has been achieved locally with imported frozen Cashmir semen (straws), following intra-uterine inseminations by means of laparoscopy, indicates that satisfactory results can be obtained from frozen semen.

Although the long-term facet is terminated, research on this important aspect will continue in the form of shorter, more in-depth, subject-specific facets.

The consistency of pig fatty tissue has been recognised to be important in meat processing and consumer acceptability. The main problem is backfat which is too soft, caused, at least in part, by high proportions of linoleic acid (C18:2) in the lipid (Whittington, Prescott, Wood & Enser, 1986). A number of researchers found that the concentration of linoleic acid in the backfat of the pig is related to its concentration in the diet.

Not only dietary factors but also sex can have an effect on the backfat fatty acid composition of the pig. According to Wood (1983), lipid extracted from boar fat tissue is slightly more unsaturated and, therefore, softer than that from castrates when comparisons are made at the same carcass mass. However, the author stated that diet has a more marked effect on fat quality than breed or sex.

A study was performed to determine whether the substitution in the diet at different live masses during growth of an unsaturated fat source (class FH sunflower seed) with a more saturated fat source (tallow) would permit the manipulation of the long chain fatty acid composition of backfat in the baconer when slaughtered at 85 kg live mass.

Seventy eight pigs (40 boars and 38 castrates) were used in a growth trial to study the effect of high oil class FH sunflower seed on the long chain fatty acid composition of backfat in baconer pigs. Three diets were formulated to contain 18 % protein, 1,0 % lysine and 13,5 MJ/kg digestible energy.

- (a) Control diet A was a normal pig growth diet.
- (b) Control diet T1 contained 16 % class FH sunflower seed (sunflower oil cake + sunflower oil).
- (c) Control diet B was similar to diet T1 but for the sunflower oil being substituted with tallow.

Seven experimental treatments were used. In Treatments A, B, and T the respective diets were fed from eight weeks of age until slaughter at 85 kg live mass. In treatments T2, T3, T4 and T5 diet T1 was fed ad lib until the pigs were 45 kg, 55 kg, 65 kg or 75 kg in live mass, respectively from which point diet B was fed until the animals were slaughtered at 85 kg live mass.

Measurements of P₂ backfat were made and backfat samples taken at the last rib. All the samples were vacuum packed and stored at -10 °C until analyses were performed. The fat samples were analysed for the long chain fatty acids (C14-C18). Data were analysed by analyses of variance using a mixed model least squares and maximum likelihood computer programme (Harvey, 1988). Growth data were calculated between 30 and 90 kg live mass by means of the Allometric Autoregressive model as described by Siebrits (1986).

The fatty acid composition of backfat of the pigs slaughtered at 85 kg live mass on the various treatments are given in Table 1.

The linoleic acid content in the backfat of the pigs that received Treatment T1 was 197 % higher than that of pigs on Treatment B. A substantial effect on stearic/linoleic acid composition is evident in the 271 % difference found between treatments, indicating an enormous effect of dietary fat source on backfat fatty acid composition.

TABLE 1 - Mean percentages of backfat fatty acids obtained at the position of the last rib of pigs slaughtered at 85 kg live mass

Fatty acid	Experimental treatments						
	A	B	T1	T2	T3	T4	T5
	(Control)	(Tallow)	(Sunflower oil)	T1 Substituted with B at live mass			
				45 kg	55 kg	65 kg	75 kg
Myristic (C14:0)	1,1 ^a	1,5 ^a	0,8 ^a	1,0 ^a	1,4 ^a	1,5 ^a	0,9 ^a
Palmitic (C16:0)	22,5 ^a	21,3 ^{ac}	16,3 ^e	18,9 ^{cf}	19,9 ^{cg}	19,0 ^{bc}	18,1 ^{befg}
Palmitoleic (C16:1)	1,0 ^a	1,5 ^a	0,9 ^a	1,2 ^a	1,5 ^a	1,3 ^a	1,2 ^a
Stearic (C18:0)	16,6 ^a	13,8 ^b	10,1 ^c	13,3 ^{beg}	12,4 ^{bhf}	11,9 ^{cgh}	11,3 ^{cdef}
Oleic (C18:1)	47,0 ^a	46,3 ^a	34,1 ^b	45,0 ^a	40,0 ^{efh}	40,0 ^{dgh}	38,7 ^{cfg}
Linoleic (C18:2)	11,1 ^a	13,0 ^a	36,3 ^b	18,6 ^f	22,5 ^g	24,6 ^g	28,6 ^c
Linolenic (C18:3)	0,8 ^a	2,6 ^b	1,4 ^{ab}	2,0 ^{ba}	2,3 ^{bc}	1,7 ^{ab}	1,1 ^{ca}
Stearic/linoleic	1,58 ^a	1,11 ^a	0,30 ^{hc}	0,72 ^{fd}	0,57 ^{cdeg}	0,49 ^{efh}	0,39 ^{gh}

a,b,c,d,e,f,g Least square means within a row bearing different superscripts differ significantly ($P \leq 0,01$)

The substitution of diet T1 with diet B resulted in a higher unsaturated backfat in the pigs as the point of substitution approached 85 kg live mass. The significant differences ($P < 0,01$) in linoleic acid content between the experimental treatments suggest the possibility to manipulate the fatty acid composition of backfat by strategically feeding diets containing fats with different levels of saturation.

No significant differences were found in growth performance or efficiency between pigs receiving T1 and B and also for Treatments T2, T3, T4 and T5.

Boars had a 12,5 % higher ($P < 0,01$) backfat linoleic acid content than castrates, probably resulting in a softer backfat.

It can be concluded that the fatty acid composition of the diet is directly reflected in the fatty acid composition of backfat. It should, therefore, be possible to change the fatty acid composition of the backfat in the pig by manipulating dietary fatty acid content. The sex of the pig is, however, also an important consideration to take into account.

Further work needs to be done to determine the maximum linoleic acid level in backfat that will yield an end product acceptable to both the consumer and the processor. Finally it is important that direct relationships between dietary fatty acids and fatty acids in the backfat should be established for use in the prediction of the effect of diet on product quality (i.e. backfat firmness).

CHICKENS

• Nutrition

VS.31170/05/1/2:

NUTRITION OF LAYING FOWLS: AMINO ACID REQUIREMENTS. 1976-1988

G.M. Schutte

A few different trials were conducted in this facet starting with the lysine requirements for laying hens.

An experiment was conducted with four laying breeds which were housed in a conventional type house. Forty hens per treatment were used, starting from day-old. Four different diets were used. Large differences occurred between breeds in respect of food intake. Egg production rose as the lysine content in the diets increased.

The second trial to determine the effect of diets with different protein, lysine and methionine levels on the productivity of laying hens. The trial consisted of eight treatments with 17 replications per treatment. The treatment containing 14 % protein proved the best showing no detrimental effects on egg production.

A trial was then conducted to optimise protein utilisation of broiler hens with a weekly "Step up", "Step down", free choice and conventional feeding system. Five replications of 58 broiler hens per treatment were used. No significant differences occurred but the "Step down" treatment produced the best results. Free choice feeding tends to cause over-consumption of feed and thus protein was wasted.

Finally, treatment feed components, namely full fat soya, sorghum, bitter and sweet lupins were analysed for their true amino acid availability (TAAA). The TAAA of the dry full fat soya treatments increased significantly with the microwave treatment. The nine-minute microwave treatment was the best. The seven-minute microwave treatment did significantly worse because of the trypsin inhibitor content. The moistured full-fat soya treatments had almost the same TAAA value. The high tannin sorghum had a very low TAAA. The NaOH and formaldehyde treatments increased the TAAA values dramatically. These treatments, however, lowered the lysine content. The NaOH treatment caused the most damage. No beneficial effect was observed by heat treating the lupin seeds.

Animal products

MEAT

• Norm studies

VS.3121/50/1/8:

MEAT AND MEAT NORM STUDIES: EVALUATION OF THE CARCASS GRADING SYSTEM FOR SMALL STOCK. 1981-1990

G.G. Bruwer

A survey was conducted on 468 lamb and sheep carcasses. Various carcass length and fat measurements were taken on different positions on the carcass. The visual fatness and conformation scores of the carcasses as determined by official graders were also recorded.

This investigation showed that the fat thickness that was measured between the 3rd and 4th lumbar vertebrae, 2,5 cm lateral of the midline, was the best predictor to explain the variation in the visual

evaluation of carcass fatness. This measurement is currently used as a guideline in the regulations for the grading of lamb and sheep carcasses.

A large number of carcasses in the top grades of the present grading system, namely Super Lamb, Prime B and Top C, as well as in the Grades Lamb 1, B1 and C1 were approximately 2 mm overfat for each fat class, according to the guidelines for fat thickness.

Subsequent to the survey, 104 lamb and sheep carcasses within the three age and six fatness classes were selected on the market and various carcass and meat evaluation determinations were performed. From this investigation it appeared that as the visual fat code increases, there was an increase in the carcass fat components, a decline in the meat yield, a decline in the bone content, a decline in the proportion of expensive meat and an increase in the proportion of lower priced cuts.

Significant differences were found between most of the fat classes for the different carcass characteristics which were examined. The percentage internal fat of some of the carcasses in fat class 4 was too high in terms of the regulations and these carcasses should be classified as overfat, i.e. fat classes 5 and 6. The different grades showed the same tendencies for the various carcass characteristics as the different fat classes, because the grades are closely linked to the different fat classes. The influence of mass and age on the carcass characteristics were negligible. The visual fatness of the carcass was found to have a significant influence on the different carcass characteristics.

As age increased there was a constant decline in meat tenderness, and increase in the residue and an increase in the cooking loss of the meat. Collagen solubility in the muscle declined (meat became more tough) with an increase in age.

Visual evaluation of the fatness was the main contributor to determine differences between carcasses with regard to content of subcutaneous fat, lean and total fat in the carcass, and was a more reliable predictor than a single objective fat measurement. The value of visual evaluation of conformation as well as carcass mass for determining differences between carcasses with respect to carcass characteristics were negligible.

The fat measurement measured between the 3rd and 4th lumbar vertebrae, 2,5 cm lateral of the midline, was the best fat measurement of the five studied for determining differences between carcasses with regard to carcass characteristics. The accuracy of a single fat measurement as a predictor increased when it was used in combination with one or more of the other four fat measurements. The objective measurement for conformation, as in the case of the visual evaluation of conformation, was not a reliable predictor of carcass composition.

VS.3121/50/1/20:

THE INFLUENCE OF SPECIFIC GROWTH PROMOTORS ON THE CHARACTERISTICS OF WOOL, SKIN AND LEATHER AND THE RELATIONSHIPS BETWEEN SKIN AND LEATHER CHARACTERISTICS OF SOUTH AFRICAN MUTTON MERINO SHEEP, 1988-1990

O. Steinhagen

The material used originates from two month-old weaned wethers used in a pilot study for growth promoters. Ninety sheep were randomly allocated to each anabolic hormonal treatment.

The respective treatments for sheep were the following:

1. Zeranol: animals implanted with 12 mg zeranol.
2. Estradiol benzoate and progesterone: animals implanted with 10 mg estradiol benzoate and 100 mg progesterone.
3. Estradiol-17B.
4. Zeranol and trenbolone acetate (TBA): animals implanted with 12 mg zeranol and 20 mg TBA.
5. Estradiol benzoate, progesterone and TBA: animals implanted with 10 mg estradiol benzoate, 100 mg progesterone and 20 mg TBA.
6. Estradiol-17B and TBA: animals implanted with 10 mg estradiol-17B and 10 mg TBA.
7. TBA: animals implanted with 20 mg TBA.
8. TBA and estradiol-17B: animals implanted with 40 mg TBA and 8 mg estradiol-17B (single implant).
9. Control: no implants.

The animals received a high energy diet. The diet consisted of 13 % crude protein and 11,09 MJ ME/kg. Each treatment group was slaughtered at an average group mass of 40 kg. The wool and skin samples were taken just before the animals were shorn. The sheep were shorn just before slaughter and the skins were preserved with salt, boric acid and naphthalene. The skins were packed and transported to a local tannery where they were put through normal wool-on production processing. The leather was evaluated with respect to leather characteristics and quality at the Leather Industry Research Institute (LIRI). Physical properties of the leathers were assessed by lastometer tests, tensile properties and slit tear strength.

The histological processing, cutting and mounting of the wool and skin samples were done according to accepted histological methods. The processed skin samples were cut horizontally and vertically to examine the following characteristics:

1. the primary follicle density;
2. the secondary follicle density;
3. coding of fat cell occurrence and
4. coding of cross-overs of connective tissue fibres.

For measuring the wool fibre length, the wool fibre was straightened on black velvet. Readings were taken with a calliper. Crimp frequency per centimeter was also counted by placing the fibre on velvet. Image analysis techniques were used for obtaining the thickness of the corium minor and corium major layers. The data was analysed with a "Statgraphics" programme written for the personal computer. For this experiment the One-Way-Analysis of Variance was used.

Of the skin characteristics observed, only fat cell coding was found to be significantly ($P < 0,01$) different between groups. Fibre length was negatively affected by the amount of trenbolone acetate present in the hormone implantations. Zeranol improved fibre growth most ($35,42 \pm 1,13$ mm) when compared to the other hormones. The effect of trenbolone acetate on the corium major caused an increase in the total thickness of the corium layer. Trenbolone acetate treatments produced stronger leather as compared to hormone treatments not containing this substance. It appears that progesterone also had a positive effect on leather strength. Thus clear indications were found that growth promoters have a significant effect on wool, skin and leather traits. The correlation was determined between skin, wool and leather traits. Primary follicle density had an important influence on leather quality as determined by the lastometer test. Wool traits proved to have an indirect influence on leather strength when leather strength was measured by means of extension at grain crack. A negative correlation was found between wool fibre diameter and primary ($r = -0,25$) and secondary ($r = -0,49$) follicle density. Wool fibre length had a significant correlation with fat cell coding in the skin ($r = -0,26$). The thickness of the corium minor is significantly correlated with total thickness of the corium layer ($r = 0,70$). Leather distension traits were influenced by the S/P ratio, although crimp frequency and the thickness of the corium major also determined distension traits. Crimp frequency had a highly significant correlation with wool fibre diameter ($r = -0,33$) and wool fibre length ($r = -0,37$). Wool fibre diameter is significantly correlated with the S/P follicle ratio ($r = -0,30$). Thickness of the corium major had a significant effect on leather quality as well as strength of the leather.

VS.3121/50/2/1:

A SURVEY OF CARCASS CHARACTERISTICS OF PIG CARCASSES IN THE RSA.
1987-1989

G.G. Bruwer

A survey was conducted amongst pig producer organisations, meat processors and consumer groups in order to identify the needs of all sectors of the pig industry regarding the required product marketing traits of pig meat in South Africa.

Information was collected regarding the characteristics of pig carcasses with the aim of developing a classification and grading system for pig meat in the RSA. Carcass data from factories as well as pig carcass competitions were analysed to assist in identifying problems and shortcomings of the present grading system.

When analysing the carcass results of five commercial centres regarding the average fat thickness and carcass mass in the different grades, it was established that for porkers, the average fat thickness for the grade Super was 11,5 mm with a range of 5-13 mm and with an average carcass mass of 46,7 kg. The average fat thickness for all porker grades is 13,9 mm, with a range from 4028 mm. The corresponding average carcass mass is 46,9 kg, ranging from 22-55 kg. Porker carcasses are distributed in the retail trade and it is quite astonishing that it is expected of the consumer to make a choice of pork ranging in fat thickness from 4-28 mm.

For baconers the variation in fat thickness in the grade Super is from 6-20 mm with an average of 16,0 mm and an average carcass mass of 66,4 kg. The ability of the current pig carcass grading system to classify carcasses into specific groups can therefore be questioned.

Variation in fat and muscle quality was also indicated by industry as matters of concern, when attempting to present a consistent product, quantitatively as well as qualitatively to the consumer.

Results of this survey lead to a comprehensive study of carcass and meat traits of various South African pig genotypes of the three sex conditions slaughtered at four specific live masses in order to develop as classification and grading system suitable for the fresh and processed pig meat industry of South Africa.

MILK

• Microbiology

VS.3123/08 3 4:

APPEARANCE, ISOLATION AND IDENTIFICATION OF PSYCHROTROPHIC BACTERIA IN RAW MILK SAMPLES. 1987-1988

G.J. Swart

The seasonal distribution of psychrotrophic bacterial counts and types in the Pretoria bulk raw milk supply was determined in this study. Twenty summer and twenty winter silo raw milk samples were subjected to the standard psychrotrophic and other bacterial counts. Individual psychrotrophic counts for all samples tested ranged from $1,4 \times 10^5$ cfu/ml whereas geometric mean counts for summer and winter samples were $2,0 \times 10^5$ cfu/ml and $1,7 \times 10^5$ cfu/ml, respectively. When expressed as a percentage of the total bacteria counts, the psychrotrophic counts accounted for 63,3 % of the bacterial content of summer samples and 69,7 % of winter samples.

An examination of a total of 424 isolates indicated that *Pseudomonas* strains (30,1 %) predominated, while Enterobacteriaceae made up 17,9 % of the isolates and *Lactobacillus* strains 10,6 %. The proportion of Gram-positive strains decreased from 38,9 % in summer samples to 27,2 % in winter samples. Members of the Micrococcaceae group were the dominant Gram-positive bacterial types (14,7 %) in the summer samples followed by *Lactobacillus* (9,5 %).

In samples taken during the winter months *Lactobacillus* (11,7 %) predominated, followed by *Streptococcus* (10,4 %). Isolates belonging to the family Enterobacteriaceae (25,8 %) were the predominant Gram-negative bacterial types in summer samples followed by *Pseudomonas* (18,2 %) and *Aeromonas* (4,7 %).

Pseudomonas strains prevailed in winter samples (41,9 %) followed by Enterobacteriaceae (10,0 %) and *Aeromonas* (4,7 %). Other Gram-negative psychrotrophs encountered in the milk included *Flavobacterium*, *Alcaligenes*, and *Moraxella*.

• Technology

VS.3123/52/2/1:

TECHNOLOGICAL CONTROL OF THE METABOLIC ACTIVITY OF PSYCHROTROPHIC BACTERIA. 1987-1988.

G.J. Swart

Literature concerning the control of psychrotrophs in raw milk has been reviewed with special reference to the use of chemical and physical processes. The chemical control referred to in this review includes the application of naturally occurring milk components such as lysozyme, lactoferrin and the Lactoperoxidase (LP) system in the control of raw milk psychrotrophs.

The LP-system was further reviewed with regard to the three components, i.e. lactoperoxidase, thiocyanate and hydrogen peroxide necessary for the activation, as well as the bactericidal action of the LP-system on bacteria and particularly psychrotrophs. Other chemical processes used in the control of psychrotrophs and referred to in this review include carbonation of raw milk, the inoculation of lactic acid bacteria in raw milk and the efficient use of detergents, sanitisers and preservatives.

Physical methods for the control of psychrotrophs have also been reviewed. These include sub-pasteurisation treatment of milk (thermisation), radurisation, bacto-fugation during bulk handling of milk and low temperature storage (-2 to -20°C) of milk.

It was concluded that although physical control of psychrotrophs are easier to apply than chemical means, chemical and biological processes such as the LP-system, inoculation with lactic acid bacteria and carbonation of milk are extremely useful in the effective control of both growth of and enzyme production by psychrotrophic bacteria in raw milk.

DAIRY PRODUCTS

• Chemistry

VS.3124/53/3/6:

LEVELS OF LINOLEIC ACID (TRANS) IN DAIRY PRODUCTS AND OILS BEFORE AND AFTER PROCESSING. 1984-1989

L.D. Nourse

Edible lipids produced in South Africa, such as butters, crude and refined vegetable oils and their hydrogenated products, were analysed for their unsaturated fatty acid content. Particularly those isomers

were investigated, which include the trans isomers that might interfere with essential fatty acid metabolism by blocking desaturase reactions.

In butters, six with a single double bond were separated by capillary gas chromatography; the predominant being oleic acid (about 18 % of the total lipid) which will compete with essential fatty acid binding to delta-6-desaturase. These unsaturated fatty acid isomers total nearly 10-fold the concentration of essential fatty acids in butters.

Only trace levels of 18:2 isomers were found. In hydrogenated oils 9 different isomers of 18:1 were separated totalling from 30-59 % of lipid. The total level depends on the oil used and the degree of hydrogenation. In margarines these would be diluted depending on the amount of oil added. The level of 18:2 isomers varied in relation to the degree of hydrogenation; highly hydrogenated oils having low levels (about 0,15 % of the total lipid) and those less hydrogenated having as much as 4 %.

At present most margarines and other hydrogenated oil products are made from highly hydrogenated oils to which is added refined vegetable oils to the level of required poly-unsaturation, so these products contain only low levels of these 18:2 isomers. Crude vegetable oils contained only oleic acid which might interfere with EFA metabolism, whereas some refined oils contained between 1-3,5 % of the 18:2 isomers. In known samples this occurred when alkali was used in refining to remove free fatty acids.

The effect these isomers might have on essential fatty acid metabolism under South African eating patterns is discussed.

Supporting animal research

ANIMALS

• *Reproduction*

V3133/04/1/2:

ANIMAL REPRODUCTION: AN IN VITRO RAT EMBRYO CULTURE BIOSSAY TO DETECT EXOGENOUS TERATOGENS.

J.M. Burgman

An in vitro rat embryo culture technique, frequently used to detect the presence of teratogens or nutritional deficiencies in relation to reproductive disorders in sera of different species, was studied. The ability of sheep serum alone, as well as sheep serum mixed with rat serum (80 % sheep:20 % rat serum), to support acceptable growth and development in rat embryos was investigated. The embryos were cultured for 48 h on media based on this serum. Rat serum was used as a control.

According to the medium parameters measured, differences between the three media types were noted. The rat medium had a lower pH ($P < 0,01$), lower bicarbonate levels ($P < 0,01$), less glucose ($P < 0,01$), lower total protein ($P < 0,01$) and a higher osmolarity ($P < 0,01$) than the other two media types throughout the culture period. The mixed and sheep medium did not differ from each other initially in pH, bicarbonate levels and glucose. At 48 h the mixed medium treated with embryos had lower pH ($P < 0,01$) and bicarbonate levels ($P < 0,01$) than the sheep medium. At 24 h and 48 h the treated mixed medium had less glucose ($P < 0,01$) than the sheep medium. The mixed medium had a higher osmolarity ($P < 0,01$) and lower total protein ($P < 0,01$) than the sheep medium. Over time an increase in osmolarity ($P < 0,01$) and total protein ($P < 0,01$) was observed in all three medium types. A drop in pH, glucose and bicarbonate levels was noted in all three medium types over time.

The most important difference noted was in the protein molecular make-up of the three culture media. There were 21 major bands in the rat medium, 23 in the sheep medium and only 18 in the mixed medium. Seven proteins unique to the rat medium, nine in the sheep medium and one in the mixed medium were detected. Two proteins present in the rat and sheep medium were not detected in the mixed medium. Although the mixed medium was a combination of the rat and sheep medium, only one unique rat protein and four sheep proteins were detected. Selective depletion of proteins in the medium containing embryos did not occur during culturing. Differences in the content of various globulins were present between the media types.

The embryos cultured in the rat culture medium had more protein ($P < 0,01$), more DNA ($P < 0,01$), more somites ($P < 0,01$), larger crown-rump lengths ($P < 0,01$) and were relatively older ($P < 0,01$) during the culture period than those in the sheep and mixed medium, although the embryos in the sheep medium were also inferior to those in the mixed medium for the same parameters ($P < 0,01$). Media type influenced the number of malformations per embryo at 48 h ($P < 0,01$). The embryos cultured in the mixed medium had far more abnormalities present than those in the rat and sheep medium, although the number of embryos showing malformations did not differ between the rat:sheep and sheep medium at 48 h. At 48 h the number of abnormal embryos in the rat medium were fewer than those present in the other two media types ($P < 0,01$).

This study has shown that the sheep serum-based medium, as used in this culture technique, cannot support adequate growth and development of rat embryos.

A study was conducted to investigate whether the quantification of those digestive energy losses which are difficult to determine, could increase the accuracy with which the metabolisable energy (ME) content of feed ingredients are estimated. Three experiments were conducted to determine whether the use of a constant ME/DE of 0,82 is warranted when the efficiency of divergent ruminant diets are compared.

In the first experiment a technique to partition methane production between the ruminal and hindgut fermentation sites of sheep was evaluated. The total methane production rates (TMP; $M\mu/min$) of four sheep, fed a lucerne or maize cob leaf diet in a change-over design, were determined in an open circuit respiration apparatus. The diets were fed at a rate of 200 g via the rumen cannula every 4 hours at 01h30, 05h30, 9h30, 13h30, 17h30 and 21h30. At 08h00 and 15h00 on alternate days the reticulo ruminal contents of each sheep was removed through the rumen cannula and maintained at 39 °C with precautions to exclude oxygen entry. The interior of the reticulo rumen was rinsed thoroughly with a saline solution to eliminate possible methane production from this site.

The sheep were then returned to the apparatus for at least one hour. Methane production during this period was assumed to originate from hindgut fermentation. The reticulo rumen methane production rate can be obtained by difference between hindgut methane production (HMP) and mean TMP.

On both the lucerne and maize cob leaf diets no significant differences ($P < 0,05$) were observed between the mean TMP before removal (21,85 and 21,45 $m\ell/min$, respectively) of the reticulo rumen contents and after returning it (22,18 and 21,60 $m\ell/min$, respectively). Neither the HMP obtained at 08h00 and 15h00 nor the differences concerning the mean TMP as well as the HMP between the two roughage diets were significantly ($P < 0,05$) different. The mean HMP over both measuring periods, were respectively, 1,48 and 1,44 $m\ell/min$. It is concluded that this technique provides a direct quantitative method for partitioning methane production in sheep between the main fermentation sites using an open circuit respiration apparatus.

It can further be concluded that, provided the reticulo ruminal contents is maintained at 39 °C with the exclusion of all O_2 for a period of about 1 hour before replacing it, the removal of digesta has no effect on subsequent fermentation of roughage diets.

In experiment 2 the same technique as in the first experiment was used with minor adaptations to determine whether it was suitable to determine the extent of heat of fermentation indirectly by quantifying the extent of carbon dioxide production (C): $m\ell/min$) owing to fermentation in the rumen. Two sheep fitted with rumen cannula were fed a lucerne diet per os at a rate of 200 g according to the time schedule of experiment one.

The reticulo ruminal contents of each sheep was removed through the rumen cannula during an one-hour measuring period when the TMP corresponded to that achieved over the four-hour feed interval. Similar but sterilised digesta of about the same mass and volume were placed in the empty rumen to facilitate normal rumen contractions. The sheep were then returned to the apparatus at 11h00 for at least one hour to measure the total gas exchange.

These measurements were repeated five times on alternative days to determine the repeatability. Fermentation heat produced in the rumen was calculated as the difference between total heat production and those corrected for the contribution of fermentation CO_2 . The mean CO_2 owing to rumen fermentation differed between 34,4 and 51,7 $m\ell/min$ for sheep 1 and 29,4 and 60,6 $m\ell/min$ for sheep 2, depending on the CO_2/O_2 used for calculation. The corresponding heat of fermentation varied between 0,25 and 0,37 MJ/day for sheep 1 and between 0,21 and 0,44 MJ/day for sheep 2.

It is concluded that owing to the variation in gas exchange and the low coefficient of estimation of CO_2 this technique is not suitable to quantify the extent of fermentation heat.

In experiment 3, two divergent concentrate to roughage ratio, pelleted diets (70:30 and 30:70), were fed per os to each of four sheep at a rate of 0,425 MJ ME $kg^{-1} W^{0,75}$ per day to determine the influence of dietary energy concentration on the ME/DE. The feed was divided in 6 equal portions according to the time schedule of experiment

Owing to problems with the apparatus and sheep only the first period was completed. Based on the data of two sheep per diet, quite similar ME/VE ratios of respectively $0,89 \pm 0,00$ (70:30) and $0,89 \pm 0,02$ (30:70) were achieved.

It is recommended that in experiments where the utilisability of diets differing in energy concentration or roughage quality or processing method are compared, the true methane production rate should be determined for the calculation of dietary ME values.

A. Kistner

In the study of the utilisation of cell carbohydrates or other insoluble substrates by micro-organisms, continuous culture techniques have a number of advantages above batch culture procedures. One of these is the possibility of examining the effect of mean retention time of particles in the fermentor on the extent and rate of solubilisation of the substrate. Where the substrate is physically or chemically heterogeneous, it is possible to determine analytically whether different components are degraded at differential rates. However, conventional continuous culture fermentors are not well suited to handling of solid substrates. A system was, therefore, developed specifically for such studies with ruminal fibrolytic bacteria.

The apparatus consists of three all-glass water-jacketted culture vessels of approximately 250 ml capacity, linked by electro-pneumatic valves and short medium lines of low hold-up volume to a common spherical medium reservoir. The contents of the reservoir and the culture vessels are agitated by efficient vibratory stirrers to keep the insoluble substrate in homogeneous suspension, and are blanked against contact with atmospheric oxygen by slow purging with a stream of oxygen-free, CO₂-containing gas mixture. Medium is dosed to the culture vessels by periodic activation of the pneumatic valves, and corresponding volumes of culture are displaced into sterile harvest vessels via exit ports with the aid of the flow of anaerobic gas through the culture vessels.

For chemostat operation, the medium reservoir is operated as a Mariotte flask and the valves receive trains of pulses from a microprocessor-type programmable sequencer which allows individual setting of pulse lengths and intervals between pulses. When pH-auxostat control is chosen, the valves are actuated by pulses from titrators in response to signals from pH electrodes which detect growth-associated pH changes. In this case, the dilution rate adjusts itself to the prevailing growth rate of the culture, and stable operation near the maximum specific growth rate of the culture is possible. For precise determinations of dilution rates, the harvest bottles can be suspended from built-in strain gauges linked to a data logger and the rate of flow of culture from the fermentors measured in terms of mass increase with time.

Tests of the system showed that the constancy of medium delivery by the relatively cheap dosing devices compared well with that of precision metering pumps, e.g. 39,6; 40,0 and 38,9 g.h⁻¹ on three consecutive days. When the contents of the medium reservoir were passed through a single, sterile culture vessel over a period of almost 5,5 days and samples withdrawn at 12-hourly intervals (which ensured an exponential turnover rate of >98 % in the fermentor between samplings), the coefficient of variation in cellulose concentration between the eleven samples was 3,38 %. The substrate flow to the cultures was thus sufficiently constant in the longer term to allow attainment of steady-state conditions and to justify the calculation, from the difference in the substrate concentration between inflowing medium and effluent culture, of extents and rates of solubilisation of substrate.

The usefulness of studies of this nature is illustrated by results of measurements on continuous cultures of *Ruminococcus flavefaciens* and *Fibrobacter succinogenes*, two important cellulolytic bacterial species of the rumen, with ball-milled filter paper as substrate. The extent of solubilisation by *R. flavefaciens* decreased steadily from close to 100 % at a dilution rate of 0,04 h⁻¹, corresponding to a mean residence time (MRT) of 25 h, to about 20 % at a dilution rate of 0,51 h⁻¹ (MRT = 1,96 h). The volumetric rate of solubilisation of cellulose initially increased with increasing dilution rate (D), reached a maximum of 200 mg per litre culture per hour at D = 0,32 h⁻¹ and then declined sharply as the critical dilution rate was approached.

Microscopic examination showed that at D = 0,32 h⁻¹ every particle of cellulose was densely colonised by the bacteria, and there were few unattached cells. At lower dilution rates, the rate of solubilisation appeared to be limited by competition for available substrate surface for the cellulases to bind to, an increasingly larger proportion of the bacterial population being unattached.

Although *F. succinogenes* is generally considered to excel at the degradation of highly ordered forms of cellulose, the strain used in the present study solubilised somewhat less than 80 % of the ball-milled filter paper cellulose at a dilution rate of 0,02 h⁻¹ and the decline in the extent of digestion with increasing dilution rate was also much steeper than in the case of *R. flavefaciens*. It is possible that the semi-defined medium used was not optimal for this relatively recent isolate of *F. succinogenes*.

The culture system is now being used to study the degradation of intact plant cell walls by defined co-cultures of fibrolytic and non-fibrolytic bacterial species from the rumen.

AGRICULTURAL RESOURCE UTILISATION RESEARCH

RESOURCE RESEARCH

Primary resources

SOIL

• Soil science

GB.5111/32/8/7:

THE PRESENCE AND DISTRIBUTION OF ANORGANIC NITROGEN IN SOILS. 1986-1989.
A.D.P. Botha

The facet was undertaken to research certain aspects of the nitrogen cycle which hampers the implementation of a more fundamental approach to nitrogen fertilisation. Specifically four aspects were examined:

1. Evaluation of methods for the determination of inorganic nitrogen in a simple but accurate manner.
2. Changes in inorganic nitrogen content of soils during fallow after cultivation of maize.
3. Movement of soluble nitrogen compounds in soils.
4. Nitrification activity in neutral to alkaline soils.

Results

Three procedures of steam distillation for the determination $\text{NH}_4^+\text{-N}$ and $\text{NO}_3^-\text{-N}$ have been compared:

1. The procedure involving distilled water and direct distillation is recommended.
2. Specific ion electrodes were also evaluated, they are easy to use, rapid and accurate enough when ammonia and nitrate are to be determined in soils.
3. A Simple and accurate ion chromatographic method was also developed in which nitrate-nitrogen could be determined directly in 2 mol dm^{-3} KCl extracts generally used to determine inorganic nitrogen in soils.

The results show that no significant changes in the inorganic nitrogen levels occurred during the fallow period.

The movement of soluble nitrogen compounds such as ammonium, nitrate and urea have been examined in soils. It has been found that nitrogen present as nitrate and urea are subject to considerable movement, whilst ammonium shows little signs of movement. In an initially dry soil, the movement of nitrate and urea follows the wetting front of the applied water. Soils at field capacity prior to water application, show a more symmetrical distribution pattern of nitrate and urea. Because urea is rapidly hydrolysed to ammonium, its movement is halted by hydrolysis.

A simple model for the prediction of nitrate movement in sandy to sandyloam soils was tested and can be used with reasonable confidence to predict the movement of nitrate during fallow, using easily obtainable soil parameters.

Results confirmed that the nitrification activity in eight soils from irrigation areas after the addition of ammonium sulphate are controlled by the initial population of nitrifiers, supply of NH_4^+ and CO_2 and especially the buffer capacity of the soils.

In spite of the great variance of this investigation, useful information was obtained which can be applied fruitfully to optimise nitrogen fertilisation.

V.5111/32/1/6:

SOIL: THE EFFECT OF FERTILISERS ON THE SULPHUR STATUS IN A HUTTON SOIL
AT GLEN. 1984-1989
A. van Schalkwyk

A field trial was conducted at the research station, Glen, in order to determine whether fertilisation with high grade, sulphur-free fertilisers, would necessitate additional sulphur applications to maintain optimum production of certain crops under irrigation. The experiment was laid out according to a randomised design with eight replications. Two treatments, fertilisation with sulphur-free and sulphur-containing fertilisers, were applied according to soil analyses and crop requirements. Lucerne, maize, wheat and sunflower were used as test crops. The yields and chemical composition of the soil and appropriate plant parts were used as criteria for the assessment of the treatment effects.

No definite advantage could be attributed to the use of sulphur-containing fertilisers in stead of sulphur-free fertilisers as far as yield, chemical composition of certain plant parts as well as the sulphur status of the top soil were concerned. The lack of response to the use of sulphur-containing fertilisers as against sulphur-free fertilisers by the crops concerned, demonstrated that adequate amounts of sulphur for normal growth and production were provided by factors other than fertilisation under prevailing conditions. Mineralisation of sulphur compounds and the presence of atmospheric sulphur may play a role in this aspect.

Seasonal differences in the chemical composition of the various crops were apparent as well as in the N:S ratios.

A marked immediate increase in the S status of the top soil was observed after fertilisation with sulphur containing fertilisers which, however, disappeared towards the end of the growing season. A depletion of sulphur in the top soil and an accumulation in the subsoil, 600/900 mm deep, were demonstrated. In the exceptionally wet 1987/88 season, even the 600/900 mm soil layer was depleted of sulphur and an accumulation took place in the 1000/1200 mm layer.

V.5111/32/1/9:

SOIL: THE EFFECT OF FERTILISERS ON THE SULPHUR STATUS OF A DUNDEE SOIL
AT UPINGTON. 1985-1989

A. van Schalkwyk

A field trial was conducted to investigate the influence of high grade, sulphur-free fertilisers in comparison to that of low grade, sulphur-containing fertilisers on the sulphur status of a Dundee soil at Upington. The experimental design was a randomised design with six replications. Two treatments, fertilisation with sulphur-free, and sulphur-containing fertilisers, were applied according to soil analyses and crop requirements. Lucerne and cotton were used as test crops under irrigation, whereas yield, hay and seed cotton, and the chemical data of appropriate plant parts were used as criteria to assess the influence of the treatments.

No statistically significant differences in lucerne hay yields were induced by the treatments. The sulphur status of the lucerne, however, was increased significantly by the use of sulphur-containing fertilisers during the first growth season only. Thereafter, no differences in any of the plant nutrients were found. The sulphur status of the lucerne in both treatments were always above the critical level of 0,22 % as postulated by several authors. N:S-ratios that varied between 15 and 8 in different seasons were calculated. Pronounced seasonal differences were exposed in some of the plant nutrient content of the lucerne.

Seed cotton yields, as well as the chemical data of the cotton leaves were not affected statistically by the treatments. Unaccountable high sulphur values were found in the leaves despite very low soil sulphate sulphur values. As in the case of the lucerne, pronounced seasonal differences were found in some of the element concentrations in the cotton leaves.

The absolute lack of a response to fertilisation with sulphur-containing fertilisers as against fertilisation with sulphur-free fertilisers by lucerne and cotton, demonstrated that adequate amounts of available sulphur were provided by factors other than fertilisation under prevailing conditions. Mineralisation of organically bound sulphur and/or the presence of atmospheric sulphur and sulphur compounds in the irrigation water, may play a major role in this aspect.

V.5111/32/1/10:

SOIL: THE DETERMINATION OF CRITICAL TEST VALUES OF SULPHUR FOR LUCERNE
PRODUCTION ON A SOIL OF THE MANGANO SERIES. 1985-1988

J. de V. Nel

The importance of sulphur as a major plant nutrient is reflected in the large number of research papers published during the past three decades. Investigators came to the conclusion that the amount of sulphur required by plants can be related to the phosphorus requirements, with the exception that sulphate sulphur is extremely prone to leaching, whereas phosphorus is relatively immobile in soils. The loss of sulphate sulphur and the increased use of high grade fertilisers with a low sulphur content, may cause severe sulphur deficiency in soils.

The main objective of this study was to determine critical sulphur concentrations for lucerne production on a sulphur-deficient sandy soil, typical of the Mangano series. This was done by means of a pot experiment conducted in a glasshouse at Glen during 1986, involving six treatments of sulphate sulphur with four replications. These treatments comprised six different levels of sulphate sulphur ranging from 0-20 mg S kg⁻¹ of soil. However, results of this experiment clearly indicated that the levels of sulphur should be increased. In 1987 the six levels of sulphur were doubled and ranged from 0-40 mg S kg⁻¹ of soil. The beneficial effect of the extended range of sulphur applications is reflected in highly correlated relationships between yield and sulphur applications ($R = 0,9939$).

In order to quantify the sulphur content of 90 % maximum yield of lucerne (115 g/pot or 23,5 tons ha⁻¹) a critical sulphur concentration of 0,25 % S could be obtained by application of the Mitscherlich equation $Y = 19,0959 - 204,595e^{-17,1728x}$ where Y represents average yield and the X the concentration of sulphur in the plant. This critical sulphur concentration represents an application of 18 mg S kg⁻¹ of soil or 59 kg S ha⁻¹. In addition the nitrogen:sulphur (N:S) and protein:sulphur ratios in the plant were investigated as alternative indices and the values thus obtained were 11,2:1 and 70:1, respectively.

The results of this investigation provide a useful and simple means to determine the sulphur requirements of lucerne.

Surveys and demarcation

SOIL SURVEYS

● Soil science

D.5131/32/1/2: SOIL CLASSIFICATION SURVEY ON FARMS OF THE WESTERN PINEAPPLE STUDY GROUP. 1986-1988
L.R. Hall

This report covers soil surveys carried out on the potentially arable areas of 16 farms of the Western Pineapple Study Group in the Albany, Bathurst and Alexandria areas. One farm lies within the Alexandria Extension Ward whereas the remainder fall into the Grahamstown Extension Ward.

The total area surveyed was 4 820 ha and the total area of the farms involved was 11 378 ha. The main objective of the survey was to provide soil series maps to be used for run-off control planning and farm planning purposes.

The soils were mapped at scale of 1:8000. Standard soil survey procedures were followed and the soils were identified in terms of the Binomial system of classification for S.A.

A total of 20 soil forms and 33 soil series were identified during this survey. The dominant series being Shorrocks (1 249,8 ha), Williamson (1 223,0 ha), Rosemead (367,4 ha), Sterkspruit (283,0 ha), Mispah (269,0 ha), Makatini (220,6 ha), Blinkklip (191,9 ha), Dohne (173,5 ha) and Jozini (119,9 ha).

These soils together account for approximately 85 % of the area surveyed and may be divided into two groups, i.e. deep well-drained soils with a low water erosion hazard rating and medium to shallow soils with low estimated available moisture capacities and high erosion hazard ratings with restricted internal drainage. These low potential soils dominate the flat crest areas and are susceptible to both wind and water erosion and, therefore, best suited to the production of permanent pastures or natural grazing.

D.5131/32/1/3: SOIL CLASSIFICATION SURVEY FOR THE COMBATting OF SOIL EROSION ON WHEAT FARMS IN THE PATERSON DISTRICT. 1987-1988
L.R. Hall

This report covers the soil survey carried out in the wheat growing areas of the Paterson district comprising approximately 45 farms, and covering an area of 15 659 hectares. Two other farms not included in the wheat growing area were included in this survey, Mount Roberts situated at Nanaga (542 ha) and Dundonald at Kinkelbos (1 430 ha).

The main objective of this survey was to identify and map the soil series of the area to be used as a guide for the purpose of run-off control and farm planning.

The mapping was done on orthophoto maps at a scale of 1:10 000 and the system of classification used was the Binomial System for South Africa.

A total of 16 soil forms were identified during this survey and 58 soil series classified of which the 9 most dominant soil forms were described in detail. The dominant series identified were as follows: Limpopo (2 064,8 ha), Letaba (1 549,2 ha), Leeufontein (1 418,5 ha), Kalkbank (991,8 ha), Dudfield (838,8 ha), Shorrocks (686,6 ha), Loskop (583,1 ha), Shigalo (528,6 ha) and Stormsvlei (463,7 ha). The remaining series together total (4 238,7 ha).

Areas covered by rock fragments accounted for 406,3 ha (2,6 %) of the area, watercourses for 221,5 ha (1,4 %) limestone outcrops for 39,3 ha (0,25 %), dune sands for 651,9 ha (4,2 %), river terrace material 88,9 ha (0,57 %), residential and other areas not classified within the survey area 298,4 ha (1,9 %). The above areas together totalled 1 300 ha or 8,3 % of the total area surveyed.

Generally the soils of this area can be described as deep to moderately deep well-drained soils with a low estimated available moisture capacity. Shallow soils (Mispah form) and others such as Kroonstad, Sterkspruit and Katspruit forms which have a restricted internal drainage occupy ± 13,5 % of the area.

The top soils in the area, irrespective of the underlying material tend to be very sandy resulting in the water and wind erosion hazard rating being extremely high. The soils of this area are in general, therefore, best suited for the production of permanent pastures or natural grazing.

RESOURCE UTILISATION RESEARCH (ANIMALS)

Ruminants

LARGE STOCK

• *Physiology*

D.5311/03/1/2:

LARGE STOCK: PROTEIN - ENERGY STATUS AND CALVING PERCENTAGE OF BEEF COWS AND HEIFERS IN THE SOURVELD. 1980-1988

J.A. Erasmus

Hand-cut and fistula samples from the sourveld and mixed sweetveld were analysed for crude protein, total non-structural carbohydrate, ash and crude fibre content.

During 1979 heifers and cows were run on the sourveld and received an NPN supplementation during the winter (sourveld + NPN). During 1980 heifers and cows were run on the sourveld mixed sweetveld (mixed sweetveld + NPN). From 1981 onwards, a third treatment group was added; heifers on the sourveld received a bone meal/salt lick during the winter (sourveld - NPN).

The crude protein content of hand-cut samples was higher on the mixed sweetveld than sourveld during the summer (6,34 vs 5,2 %, $P < 0,01$) and winter seasons 5,62 vs 4,14 %, $P < 0,001$). The same tendency was observed in respect of total non-structural carbohydrate (TNC) content, viz 4,01 vs 3,75 % and 3,48 vs 3,03 %, $P < 0,05$, respectively. The ash content of the mixed sweetveld sward was 7,41, and that of the sourveld sward 7,63 % in summer. The corresponding values during winter were 8,33 and 7,97 %, respectively. No or little differences were observed in respect of crude fibre content.

Regarding the fistula samples, it was found that crude protein content was significantly higher in samples from the mixed sweetveld than those collected on the sourveld during summer (9,22 vs 7,20 %, $P < 0,001$) and winter (7,15 vs 6,58 % $P < 0,05$). Similar results were obtained in analyses of TNC (4,10 vs 3,34 %, $P < 0,01$, and 2,91 vs 2,82 %) and ash content (8,66 vs 8,57 %, and 9,20 vs 8,42 %, $P < 0,05$). Crude fibre content was slightly lower in mixed sweetveld fistula samples, viz 34,18 vs 34,57 %, and 35,27 vs 36,07 % ($P < 0,05$) for the two seasons, respectively.

The digestibility of the Dohne sourveld and mixed sweetveld was 38 and 50 %, respectively. The oesophageal fistulated heifer on the sourveld selected a diet that was 38,5 and 45,5 % higher in protein content than that of hand-clipped samples in the summer and winter months, respectively. The corresponding diets selected by the heifer on the mixed sweetveld were 45,4 and 27,2 % higher in protein than those of the hand-clipped samples.

Lick intakes of beef heifers and cows varied from season to season. During 1979, summer lick intakes were 1220 g/animal/day; during the 1989-1983 seasons lick intakes were 326,6 g/animal/day. The intakes of lick by animals on the mixed sweetveld during the latter period were 76,8 g/animal/day. Lick intakes were 77 % lower on mixed sweetveld than on sourveld.

During the winter season on the sourveld, NPN lick intakes were 310 g/animal/day during 1979, and 338,3-354,7 g/animal/day during the 1981/82 seasons. On the mixed sweetveld, lick intakes were 181,9 g/animal/day. Lick intakes were thus 49 % lower on mixed sweetveld than on sourveld.

Animal performance was significantly enhanced on the mixed sweetveld. During the 1980 season, the mean body masses of animals on the sourveld and mixed sweetveld were 402 and 507 kg, respectively ($P < 0,001$). During the 1981/82 seasons, body masses of heifers were 405 and 492 kg, respectively. When an NPN lick was withheld during the winter season, the mass decreased to 362 kg. Body masses of heifers on the sourveld NPN, sourveld - NPN and mixed sweetveld were 434, 399 and 497 kg, respectively.

• *Nutrition*

H.5311/05/3/5:

LARGE STOCK: DIFFERENT CONCENTRATE TO ROUGHAGE RATIOS IN COMPLETE RATIONS FOR FRIESLAND BULL CALVES IN THE SUMMER RAIN CROPPING AREAS. 1985-1987.

C.W. Cruywagen

This study was undertaken to determine the effect of various concentrate to roughage ratios on pre-weaning, as well as post-weaning growth and veal production of Friesland bull calves.

Twenty-four Friesland bull calves were randomly divided into three groups at an age of two days. All calves received whole milk at a rate of 10 % of their initial body mass and were weaned at 30 days of age. Complete rations, in milled form, were offered ad lib from six days of age, and the following differences in concentrate to roughage ratios occurred between the groups: 70-30; 77,5-22,5; 85-15. Water was freely available from six days of age. Crude protein content of all three rations was 18 % until 12 weeks and 14 % until 20 weeks of age. All calves were slaughtered at 20 weeks of age.

At 10 weeks of age, all calves were subjected to a digestibility trial for a period of seven days. Apparent digestibility of dry matter, organic matter, ether extract, nitrogen-free extract, gross energy, as well as in vitro dry matter digestibility, gradually increased with an increase in concentrate content of the ration. No significant differences in digestibility of crude protein and neutral detergent fibre (NDF) were detected between groups. An increase in concentrate content of the trial rations were accompanied by a highly significant ($P < 0,01$) decrease in crude fibre digestibility. The apparent digestible crude protein percentage and digestible energy content (MJ/kg) for the 70 %-; 77,5 %- and 85 %-concentrate rations were 12,60 and 13,27; 12,59 and 13,63; 13,19 and 14,58, respectively.

No statistically significant differences with respect to body mass gain occurred between treatments. Except for one period (fourth month), no significant differences in feed intake occurred between groups. Feed intake tended to decline during both the pre- and post-weaning periods with an increase in concentrate content of the ration. Efficiency of feed conversion to live mass improved highly significantly ($P < 0,01$) for the post-weaning period and significantly ($P < 0,05$) for the total period as the concentrate content of the ration increased from 70-85 %. There were no significant differences in carcass mass and grading score between treatments. Dressing percentage was significantly ($P < 0,05$) higher for the 85 %- compared to the 70 %-concentrate group.

Where the purchasing price of maize was taken into account, gross margin was R112,52; R124,82 and R113,79 for the 70 %-; 77,5 %- and 85 %- concentrate groups, respectively.

It was concluded that Friesland bull calves can be reared profitably for veal production at 20 weeks of age. Even at the current high prices of feed ingredients, promising gross margins are possible for veal production from dairy herds. The most economical results in this study realised with a concentrate to roughage ratio of 77,5-22,5.

H.5311/05/3/6:

LARGE STOCK: THE EFFECT OF CURD FORMING ABILITY OF A MILK REPLACER ON ITS DIGESTIBILITY AND BODY MASS GAIN OF FRIESIAN BULL CALVES. 1987-1990

C.W. Cruywagen

It was concluded in a previous study that the prevention of abomasal curd formation of a milk replacer had no detrimental effect on digestibility of nutrients or body mass gain of calves when the milk replacer was fed at a constant level. It was postulated that under conditions of nutritional stress, such as increasing levels of milk replacer feeding above recommended levels, curd formation may be conducive to nutrient utilisation. The present study was conducted to test this hypothesis.

Two groups of eight Friesian bull calves each were used in the trial. A commercial, coagulable milk replacer was used, and casein coagulation was prevented in one treatment (NCM) by the precipitation of Ca^{++} with an oxalic acid sodium hydroxide buffer. The other group (CM) received untreated (coagulable) milk replacer. In both treatments, daily milk replacer feeding level (percentage of birth mass) was increased from 9 % (week 1), to 12 % (week 2), then to 15 % (week 3) and 18 % (week 4). Calves were mass-measured at weekly intervals and occurrence of diarrhoea was monitored. At four weeks of age, five calves from each treatment were randomly selected for a digestibility trial of seven days.

Body mass gain and efficiency of feed conversion (kg dry matter/kg gain) were 10,4 kg and 1,7 and 10,7 kg and 1,6 for the CM- and NCM-treatments, respectively. Digestibility coefficients were 90,2 and 91,1 % (dry matter), 91,9 and 93,6 % (organic matter), 81,0 and 85,6 % (crude protein), and 72,5 and 63,8 % (ash) for CM and NCM, respectively. Only apparent ash digestibility differed significantly between treatments.

It was concluded that prevention of abomasal curd formation had no effect on body mass gain, occurrence of diarrhoea, or digestibility of dry matter, organic matter and crude protein. Digestibility coefficients remained high, even at a daily feeding level of 18 % of birth mass.

H.5311/05/8/1:

LARGE STOCK: NUTRITIVE VALUE OF THE MORE AND LESS ACCEPTABLE PLANT PARTS OF MAIZE RESIDUES IN COMPARISON TO MAIZE RESIDUES AS A WHOLE. 1988-1990

L.D. Snyman

Nutritive value of maize plant residues were presented in three forms to growing Simmentaler steers, viz:

1. free choice selection of approximately 33 % of the residues (Treatment 1),
2. the remains after selection being milled (Treatment 2) and
3. the remains after selection being thermo-ammoniated and milled (Treatment 3).

These were evaluated by means of a growth and a digestion study.

Each treatment consisted of 11 steers, 12 months of age, mass-measuring 250 kg each. Steers in Treatment 1 preferably selected husks and leaf material (IVDMD = 67,9 %). These steers had a significantly ($P<0,05$) higher mass increase ($0,65 \pm 0,19$ kg/day) than steers fed on milled residues remaining after selection ($0,37 \pm 0,10$ kg/day). The mean dry matter (DM) intake of selected residues was 2,67 % of body mass and that of the remains, 2,08 %. Apparent DM digestibility of the selected residues was $69,2 \pm 3,0$ %, whereas steers showed a positive nitrogen retention of $50,0 \pm 19,8$ g/day. Plant material with the higher IVDMD was selected by preference.

Ammoniation of the remains increased IVDMD from 51,8-59,7 % and 51,5-59,2 % and crude protein from 4,1-11,4 % and 5,0-9,1 % for material used in the production and digestion trials, respectively. Apparent DM digestibility of the treated remains, however, was only $53,2 \pm 1,4$ % whereas a nitrogen retention of $-1,9 \pm 16,0$ g/day was measured. These were attributed to a low apparent nitrogen digestibility ($41,9 \pm 3,6$ %) owing to an abnormal high percentage of nitrogen bound to the acid detergent fibre (ADF-N) (32,5 %). Steers fed on the ammoniated remains of which the crude protein was supplemented with oil cake exhibited a mass increase of 0,67 kg/day.

In conclusion, the results of this investigation indicate that maize residues can be used for production purposes if utilised on a selective basis. This also applies for the remains after selection if these are thermo-ammoniated. The amount and nature of protein supplementation in the latter case, however, seems to be a factor which should be taken into account. Untreated remains milled through a 12-mm sieve (IVDMD = 51,8 %) contain enough for supplying the maintenance needs of steers.

N.5311/05/3/2:

LARGE STOCK: PROTEIN - CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF
TALL FESCUE PASTURE FOR LACTATING DAIRY CATTLE IN THE HIGH RAINFALL
SOURVELD AREAS AT CEDARA. 1980-1989
T.J. Dugmore

Thirty Friesian cows, blocked into three treatments, were used to determine the milk production responses to different levels of concentrate supplementation on fescue grazing. The concentrates were supplemented on the basis that the fescue would supply sufficient nutrients for:

- Treatment 1: maintenance + 6 kg milk per day (M+6)
Treatment 2: maintenance + 11 kg milk per day (M+6)
Treatment 3: maintenance + 16 kg milk per day (M+6)

The concentrates were fed at a rate of 600 grams per kilogram milk above the levels specified for each treatment. Concentrates were formulated to contain 14 % crude protein (CP) and 11,1 MJ metabolisable energy (ME)/kg as fed.

Regression equation described the milk production (FCM) response to concentrate feeding for the cows grazing fescue pasture. The overall response for four trials combined data was:

FCM = 15,5 + 0,88 (kg concentrates); n = 82; r = 0,663; $P<0,001$.

The intercepts from the regression equations indicate that at zero concentrates dairy cows on fescue, both in the spring and autumn, can produce 15,5 l FCM (550 kg medium sized Friesian cows). Cows fed no concentrate during the spring 1986 trial confirmed this level of production when no concentrates were fed (14,94 kg FCM/cow). Other researchers found that cows grazing tall fescue without concentrates produced on average 13,4 kg FCM. The response to concentrate feeding was 0,8-0,9 l FCM per kg concentrate fed (air-dry basis).

Therefore, the present milk price to commercial concentrate price ratio still justifies the use of concentrates during mid-lactation as being economically sound.

The butterfat (BF) percentages recorded during the trials were average for the Cedara Friesian herd, which has an inherently high BF level. The protein concentrations of the milk were average for the Cedara herd, indicating that fescue grazing did not adversely affect milk composition, even at high concentrate levels (9 kg concentrates for the autumn 1987 trial).

The chemical composition and digestibility of the pastures were determined for each grazing trial. These

TABLE 1 - Chemical composition and digestibility of tall fescue (cv. Kentucky 31) (DM basis)

Spring growth	Chemical composition					Digestion coefficient					TDN
	CP	CF	EE (%)	NFE	OM	CP	CF	EE (%)	NFE	OM	(%)
Leafy	19,1	24,7	1,9	42,5	88,2	76,2	73,0	41,2	66,8	70,0	62,7
Flowering	14,6	30,5	1,2	42,2	88,6	71,2	71,9	19,3	63,3	66,9	59,6
Full seed	11,6	29,2	1,8	46,8	89,4	65,3	65,3	48,2	62,7	63,6	57,9
Autumn growth											
Early April	21,7	23,5	2,7	43,4	91,3	79,1	67,6	53,4	65,3	68,8	64,6
Late April	18,4	22,3	4,4	45,6	90,7	75,2	68,7	55,1	68,6	69,3	65,9
Mid-May	14,1	22,4	2,5	51,5	90,4	69,3	63,6	38,6	70,6	67,8	62,5

are presented in Table 1. The TDN in the autumn remained relatively high, within the range 62-65 TDN, even as the season progressed, whereas the TDN of the spring kikuyu declines markedly as the grass starts seeding. This decline in the TDN value (62-57 TDN) was not reflected in the milk production of the cows grazing the pasture, owing to selective grazing.

A trial was conducted to estimate fescue intake, at three levels of concentrate supplementation, namely 3, and 9 kg per cow per day. The total dry matter available and residual dry matter after grazing were determined by pasture disc meter following calibration of the technique for fescue. The dry matter intake (DMI) was determined by difference.

The estimated dry matter intake of cows grazing tall fescue fed different levels of concentrates, was 14,45 at 3 kg concentrates, 18,14 at 6 kg and 14,84 at 9 kg. The data are not entirely consistent, with the 6 kg concentrate level recording an increased DMI of approximately 4 kg over the other treatments at 18,14 kg DM/day. This intake is far in excess of the expected DMI for dairy cows on that quality diet. The value of 14,45 and 14,84 are within the expected range of DMIs for 500-kg cows.

Fescue has proven to have good potential, and should be considered in any fodder flow designed for dairy farmers. It is ideally suited to vlei type situations, where annual cultivation is not advisable or even possible. Fescue, however, cannot compete with rye grass for prime irrigation land, because of its poorer mid-winter production, a critical factor in milk production off pasture systems.

V.5311/05/2/2:

THE EFFECTS OF FREQUENT CONCENTRATE FEEDING ON ROUGHAGE UTILISATION
BY DAIRY COWS. 1983-1989

S.W. Matthee

The effects of frequent concentrate feeding on feed digestibility, rumen parameters, feed intake, body mass changes, production parameters and milk production efficiency of dairy cows, were investigated.

Twelve mature Friesian cows were stratified into two production groups (HP - higher producers and LP - lower producers). The cows had free access to coarsely chopped (25 mm) lucerne hay, throughout the day, whereas concentrates, according to individual milk yield, were offered in two, four or eight equal portions per day. This regimen was followed during early, mid- and late lactation. A balanced cross-over design was used for each trial.

Feed digestibility was not affected by the number of concentrate portions per day. Unlike the LP cows (18,3 kg milk day⁻¹), the HP cows (23,9 kg milk day⁻¹) showed a tendency towards an increase in dry matter, organic matter, crude protein and especially fibre digestibility with an increase in number of meals, despite a lower concentrate level and a slightly higher feed intake, during the digestibility trials.

More frequent feeding of concentrates had no significant ($P < 0,05$) effect on the rumen parameters, although the mean pH and rumen ammonia concentration tended to be lower during the day. The production of total volatile fatty acids and acetic and propionic acids also tended to be increased. The diurnal variation in rumen pH, acetic:propionic acid ratio and at times ammonia and individual and total fatty acid concentrations, were decreased with an increase in the frequency of feeding (four or eight portions vs two).

The results indicate that more frequent feeding of concentrates did not significantly ($P < 0,05$) improve either feed or digestible nutrient intake. However, the more frequently fed cows of especially the HP group, tended to have a higher roughage intake.

Body mass, milk composition and efficiency of utilisation of metabolisable energy were not affected by frequency of feeding. Average milk production of the more frequently fed HP cows tended to be higher.

In conclusion, feed intake, rumen parameters, nutrient utilisation, milk production and milk quality were not significantly improved by more frequent feeding of concentrates (varying between 20 and 60 % of the ration). The effects on these same parameters will be investigated in a follow-up study, utilising high quality locally produced roughage.

SMALL STOCK

• Nutrition

H.5312/05/3/2:

SMALL STOCK: THE FEEDING VALUE OF MAIZE RESIDUES IN COMPARISON TO
THAT OF *ERAGROSTIS CURVULA* HAY AS FORAGE FOR WOOL BEARING SHEEP.
1981-1989

L.D. Snyman

The feeding value of maize residues containing a low, medium and high in vitro dry matter digestibility (IVDMD) were compared with that of *Eragrostis curvula* hay. Both forages were ground through a 6 mm

sieve and supplemented with crude protein (2 % urea), phosphorus (1 % dicalciumphosphate), sulphur (0,1 % flowers of sulphur) and sodium chloride (commercial salt, ad lib). The forages were fed on an (ad lib) basis to lambs ($\pm$ 30 kg) in a growth and digestion trial.

Lambs fed on maize residues with a comparable and in some cases with an even higher IVDMD than *E. curvula* hay, showed a significant ($P<0,05$) lower mass increase than lambs fed on *E. curvula* hay. This was ascribed to a lower intake ($P<0,05$) of digestible dry matter owing to a lower ($P<0,05$) dry matter intake (DMI) by lambs fed on maize residues. The lower DMI was explained by a higher mean content of neutral detergent fibre (NDF) measured for maize residues, causing a lower ($P<0,05$) content of dry rumen material per kg of carcass mass in lambs fed on maize residues.

Except for the lower intake of digestible dry matter, lambs fed on maize residues also showed a lower ($P<0,05$) retention of nitrogen. Ruminal fermentation properties of maize residues differed little from that of *E. curvula* hay. Analyses of iron, zinc, manganese and copper in forage and liver samples did not indicate deficiencies of any of these micro-minerals.

The IVDMD and chemical properties of maize residues and *E. curvula* hay were correlated with apparent dry matter digestibility (DMD), intake and mass changes of lambs by means of simple and multiple regression. NDF content of maize residues did not show any significant correlation with DMI. That was in contrast to *E. curvula* hay which showed a significant correlation ($r = 0,879$; $P<0,05$). A multiple regression including acid detergent fibre (ADF), lignin (L) and silica indicated significant correlations with DMI ($r = 0,896$; $P<0,05$), digestible dry matter intake (DDMI) ($r = 0,895$; $P<0,05$) and mass increase properties ($r = 0,758$; $P<0,05$) of maize residues. With *E. curvula* hay, it only showed a significant correlation with DDMI ($r = 0,990$; $P<0,01$).

IVDMD of maize residues correlated significantly with all the utilisation properties of maize residues, viz DMD ($r = 0,724$; $P<0,05$), DMI ($r = 0,905$; $P<0,01$), DDMI ($r = 0,921$; $P<0,01$) and mass change ($r = 0,966$; $P<0,01$). In the case of *E. curvula* hay, significant correlations with IVDMD were only obtained for DDMI ($r = 0,867$; $P<0,05$) and mass change ($r = 0,816$; $P<0,05$). The IVDMD of the insoluble part of maize residues during the 0-48 h incubation period was found to be correlated significantly with DMI ($r = 0,829$; $P<0,01$).

During incubation of *E. curvula* hay, IVDMD during the 12-72 h incubation period showed best correlation with DMI ($r = -0,947$; $P<0,01$). These correlations indicate that some characteristics of cell wall digestion is related, directly or indirectly, to DMI. Multiple regression including IVDMD, ADF, L and silica seemed to be the most accurate for predicting DDMI of maize residues ($r = 0,990$; $P<0,01$) and *E. curvula* hay ($r = 0,999$; $P<0,01$).

The results of this investigation suggest that certain chemical and IVDM properties of maize residues and *E. curvula* hay can be used to predict their utilisation properties with a high degree of accuracy. These data, however, indicated that the utilisation properties of different kinds of forages are not necessarily related to the same chemical properties. This is corroborated by research which indicated NDF to be a good predictor of DMI in most forages (Rohweder, Barnes & Jorgensen), whereas ADF was found to be a better predictor of the DMI of summerveld than NDF (Cilliers, 1984).

K.5312/05/1/3:

DETERMINATION OF THE OPTIMAL LEVEL OF ENERGY SUPPLEMENTATION TO DRY ANGORA GOATS ON CHOPPED NOORS *EPHORBIA COERULESCENS*. 1983-1989.

P.D. Grobbelaar

Procedure

The influence of feeding additional energy, together with Noors, on the production and quality of mohair produced by dry Angora goats, was investigated. During the first trial period (five months) the animals were fed freshly sliced Noors (ad lib), whereas during the second stage they received chopped dry Noors (ad lib). In both cases different levels of chocolate maize were fed.

In the first stage of the trial thirty adult Angora kapaters were divided into five groups of six animals each. The treatments for this stage were as follows:

Group	Treatment
1	Freshly sliced Noors (ad lib)
2	200 g chocolate maize
3	300 g chocolate maize
4	400 g chocolate maize
5	500 g chocolate maize

In the second stage, 36 animals were divided into six groups of six each. They received the same treatments as previously mentioned but only with two control groups and chopped dry Noors ad lib. Here the first control group only received chopped dry Noors whereas the second control group received chopped dry Noors treated with 5 % Calorie 3000.

After each trial period the goats, with four month's hair growth, were shorn, mohair samples were taken and analysed for hair mass, fibre diameter, length of fibres, hair wax, suint and S/P ratio.

Results and conclusion

Owing to the high moisture content ($\pm 87\%$) of Noors, the intake of Noors dry matter (DM) was much higher with chopped dry Noors than on freshly sliced Noors. On chopped dry Noors the intake of DM for the energy supplement groups was approximately 68 g per goat per day, whereas the intake of freshly sliced Noors on a dry basis, was only 565 g per goat per day.

In both cases the approximate intake of Noors by the control groups was 53 g per goat per day.

As for body mass the control groups lost about 25 % of their starting body mass within the five months of the trial and could thus not survive on Noors alone. It seems, therefore, that 200 g of chocolate maize with Noors ad lib proved to be sufficient for a dry Angora goat, mass measuring 35 kg, to maintain its body mass.

In respect of hair mass, the control groups produced 0,5 to 1,0 kg less mohair than the energy supplement groups. Fibre diameter was also approximately four microns thinner and hair length more than two cm shorter for the control group's hair. All these differences proved to be highly significant.

V.5312/05/3/4:

THE INFLUENCE OF SALT (NaCl) ON THE FUNCTION OF THE RUMEN AND PERFORMANCE OF GRAZING SHEEP. 1981-1989

H.O. de Waal

Supplementary salt (NaCl) and crude protein (CP) were provided to young Merino wethers grazing native pasture. Seven groups of 4 wethers received the following supplements daily via rumen cannulae: 0,5 (Control), 15 and 30 g NaCl; and 5, 15 and 30 g NaCl plus 20 g CP each.

During the trial period (1 year) the wethers gained respectively, 44,4 %, 67,1 %, 52,6 %, 40,7 %, 70,1 %, 57,2 % and 47,6 % in body mass. The effect of NaCl on growth became evident within 4 weeks. Rate of clean wool production (g day^{-1}) during the first 9 months was 9,02; 10,85; 9,32; 7,65; 10,53; 9,42 and 9,06, respectively.

It was evident that young sheep grazing native grass pasture in the central Orange Free State do have a nutritional requirement for NaCl, but excessive ingestion from licks could depress growth rate and wool production. Furthermore supplementary CP, in combination with high levels of NaCl, alleviated the adverse effect of NaCl to some extent.

There was a tendency for digestible organic matter (DOM) intake to decrease with incremental levels of NaCl and to increase with CP supplementation (33,8; 34,5; 31,5; 31,3; 35,5; 35,8 and 31,3 g DOM/Wkg^{0,75} day⁻¹).

Rumen pH tended to decrease with incremental levels of NaCl, as well as with CP supplementation (6,64; 6,58; 6,51; 6,59; 6,45; 6,51 and 6,25). CP and incremental levels of NaCl supplementation elevated rumen $\text{NH}_3/100 \text{ ml}$ rumen fluid). Volatile fatty acids (VFA) were not affected to any real extent by either NaCl or CP supplementation, with an approximate general VFA ratio of 76:15:9. Supplementary CP tended to decrease ruminal Na, whereas the wethers receiving 0 g NaCl had a much lower rumen Na concentration (1,367; 2,385; 2,876; 2,632; 1,674; 2,458 and 2,293 g Na l⁻¹). The wethers receiving 0 g NaCl had an elevated ruminal K concentration (2,821; 0,715; 1,031; 1,027; 0,747; 1,064 and 0,995 g K l⁻¹).

It was suggested that Na and K imbalances in the extra- and intracellular body fluid compartments, increased the maintenance energy expenditure of the wethers, thereby inducing the deleterious effects on production parameters.

• Upgrading

K.5312/07/1/6:

SELECTION CRITERIA FOR AFRINO SHEEP. 1988-1989

M.A. Badenhorst

The purpose of this study was to investigate possible selection criteria for Afrino sheep.

The data used in this study was obtained from the Carnarvon Afrino stud. The genetic and phenotypic parameters for the various growth- and wool traits were estimated by means of Henderson's Method III. First-off least-square-means corrections for sex and birth status of the lamb and for age of the dam were made before the following mixed model was fixed to the data:

$$Y_{ijk} = \mu + a_i + b_j + e_{ijk}$$

where a_i = year effect
 b_j = sire effect

The following traits were considered as possible selection criteria for ram selection: weaning mass ($h^2=0,206 \pm 0,067$), yearling mass ($h^2=0,223 \pm 0,069$), ADG-weaning-yearold ($h^2=0,222 \pm 0,069$), Kleiber-weaning yearold and adult mass cannot be considered as possible selection criteria because of their undesirable genetic correlations with birth mass and adult mass.

Kleiber-weaning-yearold has a negative genetic correlation of $-0,119 \pm 0,224$ with birth mass, a medium positive correlation with yearling mass ($0,353 \pm 0,212$) and it is almost unrelated to adult mass ($r_g = 0,104 \pm 0,224$). The high negative correlation thereof with pre-weaning growth traits must, however, be taken into consideration when deciding on selection criteria.

After all rams with too high fibre diameter indexes or too low clean-fleece mass indexes have been eliminated at twelve months of age, the remaining rams can be selected on the basis of one of two selection indexes ($I = 1 \times \text{Kleiber-birth-weaning} + 1 \times \text{Kleiber-weaning-yearold}$ or $I = 1 \times \text{weaning mass} + 1 \times \text{Kleiber-weaning-yearold}$).

As for ewe selection, ewe productivity was evaluated. Ewe productivity, for the purpose of this study, is defined as the total mass of lambs of an ewe weaned per joining. The relationships between ewe productivity and two-tooth body mass, two-tooth wool mass and two-tooth fibre diameter of the ewes were determined.

The relationship between weighted ewe productivity and two-tooth body mass was also determined. The relationship between weighted ewe productivity (total weaning mass/metabolic ewe mass) and two-tooth body mass for ewes after their first, second and fourth lambings was found to be non-significant. The same was found for the relationship between ewe productivity and two-tooth body mass for ewes after their second and fourth lambings. Therefore, ewes can be selected on the basis of ewe productivity after two lambings.

K.5312/07/4/1:

SMALL STOCK: THE IDENTIFICATION OF A FINE WOOL MERINO FLOCK. 1988-1990.
D. Wentzel

The identification and establishment of a genetically fine wool Merino flock, was the aim of this project.

Three hundred and fifty six fine wool Merino ewes were purchased from 19 different breeders. A preliminary selection of approximately 50 ewes per breeder was done by means of visual appraisal. This was followed by objective measurement of fibre diameter to allow final selection of the finest 10-20 animals of a breeder.

Finally selected animals were put on a high plane of nutrition and inseminated with semen from four imported fine wool Australian rams. A lambing percentage of 95 % was subsequently obtained. All animals are kept on artificial pastures at the Cradock Experimental Station and will be evaluated by comparing their performance to that of Merino obtained from the Grootfontein Merino flock.

• Management

N.5312/41/2/1:

SMALL STOCK: COMPARISON OF THREE LAMBING PERIODS, LATE SUMMER, AUTUMN AND SPRING WITH MERINO SHEEP IN THE HIGH RAINFALL SOURVELD OF NATAL. 1984-1989.
A.D. Lyle

Three lambing periods, late summer, autumn and spring were investigated at the Kokstad Research Station using three flocks of 70 Merino ewes each.

The late summer lambing (February and March) flock lambed on veld. The ewes received 400 g increasing to 800 g of "chocolate maize" supplement per ewe per day until the lambs were weaned in mid-May. A creep feed was available to the lambs.

The autumn lambing (April and May) flock moved from veld to irrigated pasture after lambing. The lambs were weaned in mid-July.

The spring lambing (August and September) flock grazed on irrigated pasture from two weeks before lambing to end October. The lambs were weaned in mid-December.

The late summer and autumn-born lambs were overwintered on irrigated pasture after weaning, whereas the spring-born lambs were weaned on veld.

After lambing on the veld in late summer for three years, it became clear that supplementing the ewe on the veld and providing a creep for the lamb was costly and still did not provide adequate nutrition for ewe and lamb. In order to improve the level of nutrition, this flock was lambed into a dry land fescue pasture instead of the veld in 1987.

The late summer lambing flock produced the lowest lambing percentage (72), compared with the autumn lambing flock (79) and the spring lambing flock (97), owing to mating in September when the sexual activity in Merino breeding flocks is at a low level. The lamb weaning percentages were: late summer-born lambs 62 %, autumn-born lambs 73 % and spring born lambs 70 %. The 23 % drop between the lambing

percentage and the weaning percentage in the spring flock was due to 20 % mortality just after birth caused by cold and rain after lambing in spring.

The weaning masses were lowest for the late summer-born lambs (13,4 %) and highest for the spring-born lambs (19,5 %) with the autumn-born lambs intermediate (17 kg). Lambing on fescue in late summer raised the weaning mass from 13,4 kg to 20 kg.

At 18 months of age the autumn-born lambs had achieved the greatest mass (37,7 kg) followed by the late summer-born lambs (34,9 kg) which had recovered well after their poor weaning masses. The spring-born lamb had the poorest 18-months masses (32,2 kg).

An economic analysis revealed that the margin per lamb weaned from the February lambing flock on veld produced the most expensive lamb with a negative margin of R15,56, whereas the margin for the February-born lambs on fescue was R49,73, and that for the autumn lamb was R40,13 and for the spring lamb R70,78.

In conclusion lambing in February on veld is not recommended owing to high feeding costs, poor performance of ewe and lamb and the low fertility of the ewe flock in September. It is suggested that lambing should occur in March on dryland fescue pasture as the flock fertility level will be higher in March than February and fescue pasture provides better nutrition for lamb and ewe than the veld.

RESOURCE UTILISATION RESEARCH (PASTURES)

Pasture

CULTIVATED PASTURE

• Nutrition

T.5413/05/1/1;
T.5413/05/1/2;
T.5413/05/1/3;
T.5413/05/1/4:

PHOSPHATE FERTILISATION OF *ERAGROSTIS CURVULA* IN THE DRAKENSBERG
GRAZING REGION. 1971-1990

N.G.F. Rethman

A series of eleven projects were carried out over a period of twenty years to evaluate *Eragrostis curvula* for livestock production in the high rainfall Drakensberg grazing area. The majority of the trials were undertaken at Nooitgedacht Research Station near Ermelo in the south-eastern Transvaal at an altitude of 1750 m above sea level. The climate is characterised by mild summers and cold winters and an average annual rainfall of 694 mm which is concentrated in the summer.

Choice of species or cultivar

In this respect it was clear that the major factor determining quality was stage of maturity and not inherent genetic characteristics. Ecotypes such as Pearston, Cape Province, Makwassie and Umgeni were promising alternatives to Ermelo. On waterlogged soils *E. planiculmis* has also proved a good alternative to *E. curvula*, which has only moderate tolerance to such conditions.

Seed production

This investigation confirmed the viability of using at least part of the first harvest each season for seed production to offset other production costs. This recommendation is, however, qualified by the need for 100-150 kg N/ha in spring balanced by P and K where these are deficient. Fire might also be used to stimulate seed production, but its continued careless use might even depress seed production, apart from having a dramatic influence on hay production. It is therefore recommended that only one third to one quarter of the total area be burnt each spring on a rotational basis. The lack of clarity on the influence of a long stubble highlights a need for basic studies on the stimulation of flowering culms in this species.

Fertilisation in establishment season

Although it is self-evident that reasonable levels of the major nutrients should be available to ensure a good establishment and a good production as soon as possible, it appears that even on P deficient soils heavy dressings of P fertiliser do not play a dominant role. A rational approach to P fertilisation, dependent on economic considerations, gives the manager different options. Although most workers have been relatively conservative with respect to their recommendations of the N fertilisation record, as the two sites evaluated had different optimum levels of 40 and 160 kg N/ha. In this respect, the refined techniques to determine residual soil N could simplify recommendations.

Establishment with a nurse crop

General opinion, especially of pasture workers in areas receiving more dependable late season rainfall, is that establishment of a pure stand in the late season is to be preferred. Even with the variable rainfall experienced at this time in the south-eastern Transvaal this is a viable alternative time to establish *E. curvula* pastures, provided weed control and moisture conservation measures are applied throughout the early summer. However, the majority of farmers still prefer an early season establishment with a companion or nurse crop, such as *E. teff*, during the most dependable rainfall period. It is evident that if fertility and/or moisture are not limiting and if the pasture is harvested before the teff begins to lodge (which might have a smothering effect on the *E. curvula* seedlings), satisfactory establishment and good production can be achieved when a nurse crop is utilised.

Potential for reinforcement of veld

Although this research programme has demonstrated the priority of planted pastures above fertilisation of natural veld, it is evident that fertilisation (with both N and P) can influence the successful establishment of more productive species onversown onto such veld. The wisdom of using *E. curvula* for reinforcing veld might be questioned because of expected difficulties with the management of such veld, but the success attained in these studies has demonstrated the feasibility of establishing adapted species for overseeding and the improved response to fertilisation of such veld.

N fertilisation

Findings with regard to N fertilisation were as follows:

- (a) Where hay production is the primary objective small plot trial results can be extrapolated to give a valid yield prediction for field scale production within a reasonable variation of the mean.
- (b) The seasonal variation makes a conservative yield estimate and provision for a buffer fodder bank important considerations in fodder programmes.
- (c) Although the optimum N fertilisation levels under average conditions are surprisingly high, the seasonal variation makes it advisable to split N dressings into a basic dressing in spring followed by additional dressings dependent on weather conditions.
- (d) Levels of 100 kg N/ha or less should preferably be applied as a single dressing. If however, higher levels are warranted split applications result in higher yields, a better distribution of production over the season and a more consistent quality during the growing season.
- (e) The production potential and hence optimum level of N fertilisation varies from soil to soil. The major determinant factors are the moisture relationships as determined by effective depth, drainage, moisture storage capacity and texture. Thus, sandy soils with a depth of 50-60 cm and impeded drainage, yield much better returns at Ermelo than deep (150 cm+) sandy clay loam soils with free drainage. In general shallow soils (<40 cm), very well drained soils and soils with a higher texture would have limitations. Conversely, in higher rainfall areas east of the escarpment, soils with impeded drainage suffer prolonged periods of waterlogging, whereas well drained soils have a much higher potential.
- (f) With regard to the role of P and K, it is evident that the response to N is considerably improved when these nutrients are supplied where the soil status is low.
- (g) Although this programme did not include critical fertiliser studies of pastures under grazing, where the circulation of nutrients may play a major role in either improving the reaction of fertiliser or in reducing the need for fertiliser, the results obtained from "feedback" and manuring are relevant. In both these instances yields were considerably improved, although the relative advantage must be carefully assessed.
- (h) The practice of feeding hay to livestock on the hay pasture during the dormant winter months is a relatively extensive practice and has the disadvantage that water and shelter must be provided on, or near the hay pasture. Trampling of the pasture and soil compaction might also be detrimental.
- (i) Trampling, in terms of its effect on basal cover, had an effect only where 30 t hay were fed to animals on one ha. Lower levels of feedback had no detrimental effect. Soil compaction is fortunately not a problem under the dry winter conditions experienced in the south-eastern Transvaal. However, in the southern parts of the Drakensberg grazing area, where a higher rainfall is recorded in winter, this might be a problem. Animal performance was also satisfactory, although only during the dormant season. Immediately when the pasture started to grow in spring, livestock concentrated on the green flush, with consequent loss in condition. Feeding in feedlots is the only alternative at this time.
- (j) These disadvantages are, however, more than cancelled out in the considerably improved production in subsequent seasons. These improvements, which were 20-40 % under good rainfall conditions and in excess of 100 % in drought conditions, might be partly described to the circulation of nutrients and partly to improved soil moisture status because of the organic mulch between tufts.
- (k) The alternative to "feedback" would be feedlots, where the manure produced might also be circulated back into the pasture. Although such manuring has a beneficial effect on yield responses, the effect is very small when compared with the influence of fertiliser. The economic feasibility of manuring pastures

will be dependent on the "cost" of such a practice. If the cost of transport and spreading can be legitimately debited against the feedlot (as waste disposal costs), manuring would be a proposition. Probably such manure could be better utilised by incorporating it into crop enterprises where the manure is mixed into the soil.

- (1) The effect of manure is greatest where little or no fertiliser is applied. Although some of this effect might be ascribed to recirculated nutrients, the major effect (probably 80-90 %) may be ascribed to the improved moisture conditions under the resultant organic mulch. This is borne out by the good results obtained with an organic mulch created by spreading a thin layer of milled veld grass with an extremely poor chemical composition. An attempt to improve moisture infiltration by cultivation was, however, unsuccessful in the broadcast pastures which are generally used in the high rainfall areas.

It is evident that recommendations for N fertilisation are going to vary tremendously depending on a host of interacting factors. No recipe for general application is feasible.

P fertilisation

Apart from that P fertilisation will improve the response to N when P is deficient, the results obtained in this programme leave the managers' options open. The optimum level of N fertilisation is closely linked with the level of N fertilisation. With lower levels of N (<100 kg N/ha) it is doubtful whether P fertilisation is justified, but as the level of N is increased so does the need for P and, dependent of the soil P status and pH, this might be in excess of 30 kg P/ha/year, although in most cases 10-20 kg P/ha/year is adequate. No significant differences were obtained between different forms of P, between incorporation and top dressing or between single or split applications within each season. The farmer has the choice of what, how and when to supply P on P deficient pastures. This choice will be based chiefly on economic considerations.

K fertilisation

Although K deficiencies occur less frequently than P deficiencies they are becoming increasingly common where intensive crop removal has been practised for extended periods. Where the K status of soils is low, K fertilisation improves pasture reaction to N. As the level of N is increased so is the optimum level of K. As only 40 kg K/ha is recommended when 100 kg N/ha is applied, this is increased to 60 kg K/ha with 200 kg K/ha and approximately 120 kg K/ha with 300 kg N/ha. In terms of soil status, 45-60 kg is adequate where the production potential is limited (<8-10 t/ha), whereas 75 mg/kg would be considered the threshold where the production potential is higher (>12 t/ha). In the past 260 kg K/ha or a soil status of 120-140 mg/kg were recommended for all situations. These findings are extremely important to the farmer who must rationalise his inputs without sacrificing production.

Influence of fertilisation practices on soil fertility

N fertilisation, especially at high levels, is known to have an acidifying effect on soils. What was not expected was that even LAN had an acidifying effect, which might hold implications for the availability of certain nutrients and for liming recommendations where *E. curvula* is included in a crop rotation. When high levels of N are applied, it is possible that a certain amount of carryover into the subsequent season will take place, especially if crop removal is relatively low. This carryover is, however, of short duration and not evident in the second season after fertilisation has been terminated.

Where "feedback" was implemented a similar carryover was recorded and this effect was still evident three to four years later when intensive rates of feedback (930 t/ha) were applied. Where, however, 10/t/ha was fed back on the pasture, the carryover effect had already diminished dramatically by the second season.

It was found that P status was improved only when high levels of P were combined with low levels of N. Where low levels of P were combined with high levels of N, soil P was depleted. The form of P fertiliser and the application technique, although having no significant effect on DM production, influence the P status of the soil markedly. Generally, superphosphate treatments had a higher P content than Langfos treatments (12-16 %) and this difference might be ascribed to the recovery of different forms of P by low stocking rates (SR) (± 3 AU/ha at the start of the season) there was little choice between continuous and rotational grazing. At higher SRs (4,5 AU/ha), however, a definite advantage in rotational grazing, particularly under drier conditions, were found.

Given that rotational grazing, requiring four to six paddocks/herd or flock, should be the basis of utilising *E. curvula* for grazing, the producer has two further basic decisions to implement. A variable SR by adjusting stock numbers periodically on the basis of expected or actual growth rate should be used. However, a shortage of available pasture (AP) should at no time limit intake or livestock performance. The alternative strategy is to keep a constant number of animals, based on a conservative pasture growth rate, but to withdraw a portion of the pasture during periods of rapid pasture growth. The surplus material could be conserved as hay. The principle of non-limiting AP also applies for this strategy. As many South African pasture scientists, including Grunow and Brockett, have opted for the first strategy - "put and take" on the

basis of animal numbers - research on the Nooitgedacht Research Station has employed the second strategy of "put and take" on the basis of pasture area being grazed. The reason for this decision was:

- to provide hay needed for overwintering;
- to ensure that AP was never limiting;
- to incorporate moving and grazing into the same rational system so that paddocks can grow out periodically (a rotational rest) and to minimise the detrimental effects of area selection in a mono-specific pasture; and
- to manipulate the availability of paddocks at an "ideal" growing stage.

The second basic decision concerns the concept of rotational grazing. An arbitrary rotation of the emphasis is placed on frequent harvests at a young growth stage, avoiding burning or low cutting, both of which stimulate the production of flowering tillers and hence fibrous material. Where livestock has a lower nutritional requirement, part of the hay may be harvested at a later stage of maturity. It must be recognised, however, such hay takes longer to cure and is subject to further nutrient losses during the hay making process.

Utilisation of summer grazing

Recognising that a rotational grazing system is a must under unpredictable or low rainfall conditions, the management decisions to be made, concern stocking rate, combination of grazing and hay making in an open rotation and the utilisation philosophy in moving livestock. Under the variable seasonal production conditions reported in the south-eastern Transvaal, it is self-evident that the combination of a conservative stocking rate with a grazing/hay open rotation offers the farmer the desired flexibility to manipulate the grazing area ("put and take") dependent on growing conditions. The occasional hay cut also has the advantage that:

- winter feed is produced;
- problems with selectivity are minimised, and
- the availability of paddocks at an "ideal" growing stage may be manipulated.

It is clear that a high production grazing philosophy yields better results than a high utilisation grazing programme, although management inputs are also higher for the former strategy. With the basic information collected, it will also be possible to combine the two approaches with two herds or flocks. The first consisting of animals with high maintenance, could be used to "clean-of" the residual material

• Upgrading

N.5413/07/1/7:

THE DEVELOPMENT OF A WHITE CLOVER FOR USE IN THE EASTERN HIGH
POTENTIAL AREAS OF SOUTH AFRICA. 1977-1988

A. Smith

The problems associated with the use of white clover in pastures in the eastern high potential areas of South Africa, i.e. high P requirements, low tolerance to high Al levels and low pH in the soil, as well as a limited survival time of approximately 30 months, were identified. It was found that these problems are related to the inadequate root system of white clover cultivars.

During the improvement programme cultivars available on the world market were introduced and evaluated under dryland conditions. Selections were made from these introductions on the basis of root conformation in high Al low pH soils, their response to grazing and induced moisture stress.

A laboratory technique for the improvement of Al tolerance was developed and the tolerance of white clover plants to high levels of Al was improved but owing to the complexity of pasture plant improvement it was decided that the selection for tolerance to Al could be more effectively carried out in the field.

The effectiveness of Vesicular arbuscular mycorrhizas as phosphate gatherers indicated that local strains of mycorrhizas combined as effectively with white clover as the imported strains.

As no seed production of white clover is undertaken in South Africa guidelines for local seed production were also established.

As a result of the improvement programme, *Trifolium repens* cv. DUSI was developed as an open pollinated synthetic variety, based on 38 selected mother lines. DUSI has a greater tolerance to high Al low pH and low P in the soil. Owing to an improved root system with a high percentage of secondary taproots it produces better under dryland conditions and has a longer stand life than any of the white clover cultivars available on the local market.

Plant breeders rights were obtained for cv. DUSI and the cultivar was inscribed on the South African variety list. Limited amounts of breeders seed have been made available to the South African Forage Seed Association for commercial seed production.

• *Crop Science*

T.5413/30/1/1;
T.5413/30/1/2:

CUTTING HEIGHTS OF *ERAGROSTIS CURVULA* IN THE DRakensberg Grazing
Region. 1973-1990
N.G.F. Rethman

(See T.5413/05/1/1; etc. under *Nutrition* for text)

• *Potential studies*

T.5413/36/2/1;
T.5413/36/2/3;
T.5413/36/2/4:

EVALUATION OF LEGUME PLANTS IN ASSOCIATION WITH *ERAGROSTIS CURVULA* IN
SOUTH-EASTERN TRANSVAAL. 1973-1990
N.G.F. Rethman

(See T.5413/05/1/1; etc. under *Nutrition* for text)

• *Management*

T.5413/41/1/1;
T.5413/41/1/3:

OPTIMAL UTILISATION OF *ERAGROSTIS CURVULA* PASTURE BY BEEF
CATTLE IN THE SOUTH-EASTERN TRANSVAAL. 1974-1990.
N.G.F. Rethman

(See T.5413/05/1/1; etc. under *Nutrition* for text)

LEGUME FODDER CROPS

• *Crop Science*

T.5417/30/1/3:

SCREENING OF PASTURE LEGUMES FOR SOIL ACIDITY TOLERANCE. 1977-1989
E.D. Wassermann

A pot experiment and an irrigated field trial in which the response of sainfoin and lucerne to different levels of P K and lime was compared, are described. The results of the pot experiment suggested a better response to lime in sainfoin than in lucerne. On the other hand, the P and K requirements of lucerne appeared to be considerably higher than those of sainfoin.

Apart from an inconclusive result with regard to the P response, the finding of the field trial, which extended over two seasons, supported those of the pot experiment. The response to P was apparently hampered in this trial by the extremely low K reserve of the particular soil. Lucerne outyielded sainfoin by a wide margin in the field and its crude protein content was considerably higher.

RESOURCE CONSERVATION

Planning of areas

FARM PLANNING

- *Agrohydrology*

N.5831/34/1/3:

RUN-OFF CONTROL PLANNING IN THE IXOPO EXTENSION WARD. 1979-1989
A.D. Simpson

Provision of run-off control plans (ROCPs) on all land within Run-off Control Blocks (RCB) 1-3 on the ward were investigated.

The three RCBs were found to have 12 100 ha of arable land, 6,5 % of which was down to permanent pasture and 52 % which was down to timber. Of the 5 000 ha of annually cropped land, 48 % was found to be unprotected. ROCPs for these areas were supplied to the landusers and efforts are now underway to get these run-off control plans implemented.

ENTREPRENEUR DEVELOPMENT

EXTENSION SCIENCE INVESTIGATIONS

Resources and technology

MANAGEMENT FACTORS

- *Persuasion*

T.6114/39/1/5: MANAGEMENT FACTORS: PERSUASION OF FARMERS TO OPTIMAL RESOURCE UTILISATION IN THE KOEDOESRAND AREA. 1976-1990
S.W. Burger

With a communication programme of this nature it must be accepted that the same degree of success is not possible. For example, in the case of crop production innovations are relatively inexpensive, easy to apply and also measurable over the short term. Furthermore, results can be obtained over a period of time with correct veld management practices and this can be destroyed within two to three seasons under unfavourable climatic conditions.

Regarding the change in circumstances over the last few months it was recommended that the communication programme in the Koedoesrand area be suspended.

MAN

- *Situation analysis*

H.6115/35/1/1: THE ACHIEVEMENT OF STUDENTS AT COLLEGES OF AGRICULTURE: AN ANALYSIS OF SUCCESS DETERMINING FACTORS. 1983-1990
C.J. Louw

Agricultural training of prospective farmers is expensive. The average failure rate of 25 % at the colleges of agriculture in the RSA results in the facilities not being utilised optimally. The aim of this study was, in order to develop an effective selection system, to identify the most important variables determining success.

A literature study showed that the influencing variables could be broadly classified into aptitude, interest, motivation, school performance and certain personal characteristics and circumstances. It was hypothesised that all these factors would also have a positive influence on academic success at a college of agriculture.

Information was obtained from the 1985 first-year students at the Potchefstroom College of Agriculture by means of a constructed questionnaire and standardised psychometric tests. The measure of academic success was the total percentage obtained in the examinations at the end of the year.

Research results supported the hypothesised relationship between school and college achievement.

Because of the large variety of subjects, only the influence of the two official languages was tested and it was found that the better the symbols obtained in both languages, the better the probability for academic success at college.

Evidence in support of the hypothesis that interest has a positive influence on achievement was insufficient, whereas quite a few clear indications were found in the case of aptitude. Especially IQ showed a positive relationship with academic achievement, but did not guarantee success.

Only a few personal and environmental factors showed a relationship with achievement, but in most cases less than expected. Military rank was found to be a good predictor of academic success but the relationship is possibly a result of other causal factors.

Similar results were obtained regarding variables used as indicators of motivation. The relatively small relationships between motivation and achievement did not support the hypothesis that aptitude and other personal and environmental variables would find expression via motivation and learning behaviour in achievement, but could be explained on the grounds of diverse influences, problems of reliability and criteria deficiencies. The latter especially represents a challenge for future research.

For selection, the obvious direction lies in the use of the more dependable variable, school achievement, supplemented with certain aptitude aspects. Motivation, however, remains important and although difficult

to measure should be taken into consideration when selecting students. Findings showed that even a single aspect of indication of motivation can have a decisive influence on achievement. This illustrates the limitations of a general selection scale that does not necessarily accomodate the uniqueness and complexity of an individual.

For the present, selection focussed on achievement appears to be the most appropriate approach. Only when future research has illuminated the relationship between academic achievement and farming success, will it be possible to develop a more meaningful mechanism for prospective farmers.

BOTANY

BOTANY RESEARCH

Research collections

NATIONAL HERBARIUM

- *Taxonomy*

PL.7141/01/1/1:

DEVELOPMENT OF A SPECIAL VEHICLE, APPARATUS AND LABOUR-SAVING DEVICES
AND METHODS FOR PLANT COLLECTING FOR THE NATIONAL HERBARIUM,
PRETORIA. 1984-1990

M.D. Panagos

A long wheel-base Nissan Ekonovan was acquired for use as the special collecting vehicle. Interior modifications included a protective expanded metal grid between the load bay and the front seat, a system of racks and bins for storage of pressing material, seed, spirit material, plastic bags, etc., a single seat and working surface, a window on one side and a 12-volt fluorescent lamp for improved lighting, a portable map cabinet, a transportable camping kitchen and a two-way FM radio for use in emergencies.

Further additions to the vehicle included a roofrack designed in consultation with the Aerodynamics Research Institute, to hold 12 ten-kilogram plant presses. An awning was attached to the side of the roofrack to provide shelter for workers. A towbar and hitch and a winch were also fitted to the vehicle.

Various labour-saving devices were designed and manufactured for this facet. Six 'Thermostatpresse' (Widder, 1970) capable of drying the contents of three average-sized field presses at a constant temperature, were built by the CSIR. A Cadac Skottelskaar Braai was modified for use as a gas drier for field drying of plant specimens. A customised trailer drier-transporter was purchased and top-loading plant presses were made by Agricultural Engineers, Department of Agricultural Development, for use in the trailer. A light mass plastic plant press which can be mounted either on a backpack frame or slung over the shoulder was made.

SCIENTIFIC ARTICLES
WETENSKAPLIKE ARTIKELS

PLANT PRODUCTION PROMOTION PLANTPRODUKSIEBEVORDERING

AGRONOMY RESEARCH/AKKERBOUNAVORSING

Summer grain/Somergraan

MAIZE/MIELIES

• Nutrition/Voeding

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• Genetics/Genetika

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• Pathology/Patologie

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• Crop science/Gewaskunde

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- *Pathology/Patologie*

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Small grain/Kleingraan

WHEAT/KORING

- *Genetics/Genetika*

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BARLEY/GARS

• *Upgrading/Veredeling*

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Animal production/Diereproduksie

BEEF CATTLE/VLEISBEESTE

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PATHOLOGICAL INVESTIGATIONS/PATOLOGIESE ONDERSOEKE

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POULTRY/PLUIMVEE

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• Protozoology/Protosoölogie

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AGRICULTURAL RESOURCE UTILISATION LANDBOUHULPBRONBENUTTING

RESOURCE RESEARCH/HULPBRONNAVORSING

Primary resources/Primêre hulpbronne

SOIL/GROND

- *Soil science/Grondkunde*

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- *Technology/Tegnologie*

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CLIMATE/KLIMAAT

- *Remote sensing application/Afstandwaarnemingstoepassing*

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- *Potential studies/Potensiaalstudies*

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RESOURCE UTILISATION RESEARCH (CROPS) HULPBRONBENUTTINGSNAVORSING (GEWASSE)

Field crops/Landgewasse

SUMMER GRAIN/SOMERGRAAN

- *Crop science/Gewaskunde*

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- *Pests/Plae*

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Ruminants/Herkouers

LARGE STOCK/GROOTVEE

• *Physiology/Fisiologie*

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• *Nutrition/Voeding*

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• *Reproduction/Reproduksie*

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AUXILLIARY SERVICES/HULPDIENTE

Office and other administration/Kantoor- en ander administrasie

CONTRACT RESEARCH/KONTRAKNAVORSING

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- GG.2111/31/2/2: The measurement of available soil moisture, root development, growth and production of maize on an Avalon soil in situ. 1981. R. Mottram

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- GG.2111/35/1/1: The monitoring of fertilisation, tillage, weed control and pest control practices in maize production. 1986. C.H. Heenop

• *Modelling/Modellering*

- GG.2111/42/1/1: The quantification of maize production risk. 1986. R. Mottram

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Small grain/Kleingraan

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- GG.2122/07/2/1: The selection of meiotic stable breeding parents from advanced triticale lines. 1976. H.A. van Niekerk
- GG.2122/07/3/1: The evaluation of triticale germ plasm. 1981. I.B.J. Smit
- GG.2122/07/3/2: The upkeep of unique triticale germ plasm. 1981. M.T. Aartsma

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- GG.2123/05/1/1: Effect of nitrogen fertilisation on the production and quality of durum wheat under irrigation. 1982. W.H. Killian

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- GG.2124/07/1/1: The breeding of barley and evaluation of elite newly developed and imported cultivars. 1976. P.B. le Grange
- GG.2124/07/2/1: The evaluation of barley germ plasm. 1981. I.B.J. Smit
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- GG.2124/07/3/1: Quality evaluation of all new barley lines for brewing characteristics. 1976. L. van Lill

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- GG.2124/19/1/2: Chemical control of foliar diseases and its effect on yield and quality of barley in the Western Cape Province. 1988. D.B. Scott

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- GG.2126/07/1/1: The evaluation of elite newly developed oat lines and introductions. 1976. M.T. Aartsma
- GG.2126/07/2/1: The evaluation of oat germ plasm. 1981. I.B.J. Smit
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- GG.2131/03/2/1: The influence of varying temperatures on the gynophore and pod set of groundnuts. 1983. J. Dreyer

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- GG.2131/05/1/1: NPK fertiliser studies with groundnuts. 1983. H.L. Loubser
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- GG.2131/07/1/5: Studying and development of anther culture techniques in aid of development of new groundnut cultivars. 1986. P.C.W. van der Walt
- GG.2131/07/1/6: Identification of resistance of groundnut genotypes of *Ditylenchus destructor*. 1988. E.M. Jordaan

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- GG.2131/19/1/1: Fusarium diseases of dryland cultivated groundnuts. 1985. S.H. Swart
- GG.2131/19/2/1: *Macrophomina* infections on groundnuts. 1985. E.L. Holtzhausen
- GG.2131/19/3/1: The influence of groundnut root and pod exudates on *Chalara elegans*. 1984. J.R. Anderson
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- GG.2131/20/2/2: The occurrence of *Ditylenchus destructor* on groundnuts and its effect on groundnut production. 1987. C. Bolton

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- GG.2131/30/3/1: The influence of planting date on runner type groundnuts. 1985. C.J. Swanevelder
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- GG.2131/30/8/1: Studies on spacing with newly released groundnut cultivars. 1985. C.J. Swanevelder

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- GG.2131/31/1/1: Crop factor determination for groundnuts under irrigation. 1988. W. Jansen
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- GG.2132/05/1/4: The effect of mycorrhiza on the utilisation of phosphorus by sunflowers. 1985. H.L. Loubser
- GG.2132/05/1/5: The influence of nitrogen and moisture levels on the growth and yield of sunflowers. 1985. H.L. Loubser
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- GG.2132/07/1/1: Introduction and evaluation of sunflower lines for use in a breeding programme. 1974. W.J. Vermeulen
- GG.2132/07/1/2: The breeding of sunflower restorer lines and composites for utilisation in hybrid breeding. 1974. B.C. Greyling
- GG.2132/07/1/3: The breeding of sunflower A/B lines and composites for utilisation in hybrid breeding. 1974. W.J. Vermeulen

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- GG.2132/19/1/1: *Macrophomina* infections of sunflower. 1985. E.L. Holtzhausen

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- GG.2132/30/1/1: Evaluation of sunflower cultivars in different production areas. 1978. H.L. Loubser
- GG.2132/30/1/2: The ability of sunflower cultivars to compensate for low plant populations. 1983. H.L. Loubser
- GG.2132/30/1/5: Self-pollination and self-compatibility of sunflower cultivars. 1985. E.B. Birch
- GG.2132/30/1/6: Tolerance of sunflower cultivars to Al toxicity. 1983. E.B. Birch
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- GG.2132/42/1/1: Predicting of the effect of nitrogen fertilisation and moisture supply on the yield of sunflowers. 1985. H.L. Loubser

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- *Physiology/Fisiologie*

- GG.2133/03/1/2: Interaction between yield components and interplant competition of soybeans. 1985. M.A. Smit
- GG.2133/03/1/3: Identification of soybeans on a biochemical level. 1987. C. Sullivan

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- GG.2133/07/1/1: Evaluation of soybean lines/introductions for use as commercial cultivars and/or as parents in a breeding programme. 1983. T.E.M. Odendaal
- GG.2133/07/1/2: The selection and generation of segregating material. 1984. T.E.M. Odendaal

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- GG.2133/23/1/1: The specific susceptibility of different soybean cultivars to herbicides. 1987. T.H. Bantjes

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- GG.2133/30/2/1: Basin tillage in soybean production. 1984. E.B. Birch

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- GG.2134/05/1/1: The effect of nitrogen application levels at different growth stages of dry beans. 1983. A.J. Liebenberg

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- GG.2135/03/1/1: A study on the effect of daylength and temperature on the growth and development of *Lupinus albus*, *Lupinus mutabilis* and other lupin species. 1985. J.A.M. van der Mey
- GG.2135/03/2/1: A survey on the occurrence of different alkaloids in lupin species and lines for the summer rainfall areas. 1985. J.A.M. van der Mey
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- GG.2135/30/3/1: Determination of sensitivity of lupin cultivars and breeding lines to chemical weedkillers in the summer rainfall areas. 1985. A.P.J. de Beer
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- GG.2135/30/3/3: Control of grasses and grass-like weeds in lupin plantings in the summer rainfall areas. 1985. A.P.J. de Beer

OTHER SEEDS/ANDER SADE

• Virology/Virologie

- GG.2136/12/1/1: Development of techniques for rapid and sensitive screening of *Vigna* germ plasm for virus infections and identification of virus types on *Vigna* in South Africa. 1986. J.J. Coetzee

• Crop science/Gewaskunde

- GG.2136/30/1/1: Other seeds: introduction of cowpea breeding material. 1985. J.J. Coetzee
- GG.2136/30/2/1: Other seeds: evaluation of bambara in different production areas. 1984. C.J. Swanevelder

Other agronomic crops/Anders akkerbougewasse

COTTON/KATOEN

• Physiology/Fisiologie

- TK.2141/03/1/3: The effect of moisture stresses and lower night temperatures on CO₂ absorption of short-season cotton cultivars. 1988. D. Meyer
- TK.2141/03/1/4: The effect of moisture stresses at different growth stages on CO₂ assimilation, growth and yield of different cotton cultivars. 1988. D. Meyer

• Nutrition/Voeding

- TK.2141/05/1/1: Response of cotton to nitrogen application with petiole analyses as diagnostic aid. 1980. M.C. Dippenaar
- TK.2141/05/1/2: Long-term NPK fertiliser study with cotton. 1972. M.C. Dippenaar
- TK.2141/05/1/3: Influence of mutual relation among nutrient elements in the soil and in cotton plants on the yield potential. 1983. N.J.J. Combrink
- TK.2141/05/1/6: Determination of the chemical composition of plant components of cotton cultivars during the growing season. 1988. F.J. Shawe
- TK.2141/05/1/7: Phosphate nutrition of cotton. 1988. C.J. Steenkamp
- TK.2141/05/1/10: The influence of the previous crops on the nitrogen needs of cotton. 1988. E.J. Haumann
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• Upgrading/Veredeling

- TK.2141/07/1/1: Cotton breeding and selection. 1974. A.I. Greeff
- TK.2141/07/1/2: Introduction of cotton breeding lines and cultivars from abroad. 1974. A.P.F. Cornelissen
- TK.2141/07/1/4: Evaluation of the earliness of cotton (*Gossypium hirsutum*) as a factor in better insect pest and agronomic management. 1985. H.G. van Heerden
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- TK.2141/07/2/2: National cotton cultivar trials. 1975. G.S.P. Vink
- TK.2141/07/2/3: Recovery of cotton breeding lines after a period of moisture or temperature stress. 1983. H.G. van Heerden
- TK.2141/07/3/1: The investigation of fibre development of cotton by means of biotechnological methods. 1989. M.S. Hill

• *Pathology/Patologie*

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- TK.2141/19/1/4: Seed dressing fungicides for the control of seedling disease of cotton. 1988. A. le Roux
- TK.2141/19/1/5: The interaction between *Meloidogyne incognita* race 4 and *Verticillium* wilt of cotton. 1988. R.J. van Wyk
- TK.2141/19/1/6: Resistance against *Rhizoctonia* in cotton germ plasm. 1988. A. le Roux
- TK.2141/19/1/7: To investigate the *Xanthomonas campestris* pv. *Malvacearum* races in South Africa for potentially new and unidentified races and the typing of these races. 1989. M.A. Mulder

• *Pests/Plae*

- TK.2141/20/1/2: Survey and identification of parasitic nematodes in different cotton producing areas. 1982. R.J. van Wyk
- TK.2141/20/1/3: The effect of nematocides on different nematode species and populations on cotton. 1985. E.R. van Biljon
- TK.2141/20/1/4: The refinement of infra-red detection techniques (for remote sensing) to determine nematode infestation in cotton for improved management. 1985. M.S. Greeff
- TK.2141/20/1/5: Survey of parasitic nematodes which occur in association with cotton including rotation crops and weeds. 1986. M.S. Greeff
- TK.2141/20/1/6: Development of mass rearing techniques of *Paratrichodorus* spp. (stubby root nematode), including in vitro mass rearing in cotton. 1988. E.R. van Biljon
- TK.2141/20/1/7: Evaluating cotton breeding lines and cultivars for resistance against *Meloidogyne* and *Pratylenchus* species. 1988. M.S. Greeff
- TK.2141/20/1/8: Control of nematodes under dryland conditions. 1988. E.R. van Biljon
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- TK.2141/20/2/3: Pest status of boll worm and flea beetle on ratoon cotton. 1987. E.G. Eulitz
- TK.2141/20/2/5: Evaluation of chemical products for the control of the boll worm complex in cotton. 1988. R. van der Westhuizen
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- TK.2141/20/2/8: Occurrence of pests and predators in dryland and irrigated cotton. 1988. A. Nel
- TK.2141/20/2/9: Threshold values for chemical control of boll worms. 1988. R. van der Westhuizen
- TK.2141/20/2/11: The determination of rate of development of *Heliothis armigera* at different temperatures. 1990. A.L. Bennett
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- TK.2141/21/1/1: Determination of the fitotoxic effect of chemical herbicides on cotton. 1988. C.R. Nolte

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• *Water requirements/ Waterbehoefies*

- TK.2141/31/1/4: The effect of irrigation and dripper spacing on the growth and yield of cotton. 1988. C. Barnard
- TK.2141/31/1/5: The effect of lateral irrigation and mepikwat treatments on growth and yield of cotton. 1988. C. Barnard
- TK.2141/31/1/6: The effect of irrigation systems, irrigation management and plant population on growth and yield of cotton. 1988. C. Barnard
- TK.2141/31/1/7: Improved non-stress baseline based on the plant water status for use in cotton irrigation scheduling. 1989. V.P. Moore
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TOBACCO/TABAK

• *Physiology/ Fisiologie*

- TK.2142/03/1/1: Measuring of physical characteristics of flue-cured tobacco leaf. 1987. N.J.J. Combrink
- TK.2142/03/1/2: Measurement of leaf ripeness before harvest. 1987. N.J.J. Combrink
- TK.2142/03/1/4: The effect of moisture stress on CO₂ assimilation, plant development and leaf quality of flue-cured tobacco. 1988. D. Meyer
- TK.2142/03/1/5: The critical level of the plant water stress index for photosynthesis in tobacco. 1989. R.M. Zipp
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- TK.2142/03/2/1: An investigation of the structure of the leaf trichomes of tobacco. 1988. M.J. van der Merwe

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- TK.2142/07/1/2: Determination of breeding value of dark air-cured tobacco. 1964. V. le Grange
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- TK.2142/07/1/4: Determination of breeding value of burley tobacco. 1969. H.G. van Heerden
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- TK.2142/07/1/12: A germ plasm collection of tobacco (*Nicotiana*). 1985. A.P.F. Cornelissen
- TK.2142/07/1/13: The role played by in vivo and in vitro translation systems for the characterisation and screening of potato virus Y strains in different tobacco cultivars. 1986. M.J. Bosch
- TK.2142/07/1/14: The transfer of disease resistance from *Nicotiana repanda* to *Nicotiana tabacum* cultivars. 1986. M.J. Bosch
- TK.2142/07/1/15: Improvement of air-cured tobacco varieties via the anther culture technique. 1986. M.J. Bosch
- TK.2142/07/1/16: Production and evaluation of F₁-hybrids and male sterility types of potential tobacco breeding materials. 1987. A.P.F. Cornelissen
- TK.2142/07/1/17: The inheritance-pattern of the resistance to root-knot nematodes in certain (KNST) tobacco breeding lines. 1985. A.P.F. Cornelissen
- TK.2142/07/1/18: Breeding of commercial flue-cured tobacco varieties with resistance to root-knot nematode. 1985. A.P.F. Cornelissen
- TK.2142/07/1/19: Production of air-cured tobacco varieties with root-knot nematode resistance. 1986. A.P.F. Cornelissen
- TK.2142/07/1/20: Production of burley tobacco varieties with root-knot nematode resistance. 1986. A.P.F. Cornelissen
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- TK.2142/07/2/5: Evaluation of Oriental tobacco breeding lines. 1958. H.G. van Heerden
- TK.2142/07/2/6: The influence of topping stages on yield and quality of newly developed burley breeding lines. 1989. H.G. van Heerden
- TK.2142/07/2/7: The potential of tobacco genotypes in producing nicotine and nor-nicotine. 1989 M.S. Hill
- TK.2142/07/3/1: Evaluation of advanced breeding lines of flue-cured tobacco for the release of cultivars. 1986. H.G. van Heerden
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- TK.2142/19/1/11: Evaluating tobacco cultivars for resistance against *Rhizoctonia solani*. 1988. J.C. Meyer
- TK.2142/19/2/4: Investigation of vectors and vection of Potato-Y virus of tobacco in the Lowveld: survey and identification of aphids and other insects. 1985. N.C.L. du Toit
- TK.2142/19/2/6: Evaluation of *Nicotiana* species and *N. tabacum* cultivars for resistance against tomato spotted wilt virus. 1987. D.J. de Bruin
- TK.2142/19/2/7: A survey of the occurrence and distribution of economic important tobacco viruses in the tobacco production areas of the RSA. 1987. A. Swanepoel
- TK.2142/19/2/8: Evaluation of *Nicotiana* species, *N. tabacum* cultivars for resistance against the four races PVY. 1987. R.J. van Wyk
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- TK.2142/19/2/10: The influence of alternative host plants on the occurrence and distribution of TMV, CMV, PVY and TEV. 1987. A. Swanepoel
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- TK.2142/19/3/2: Screening for resistance among *Nicotiana* spp. cultivars and breeding lines against *Pseudomonas solanacearum*. 1985. M.C. Engelbrecht
- TK.2142/19/3/3: Chemical control of bacterial wilt in tobacco. 1986. M.C. Engelbrecht
- TK.2142/19/3/4: The influence of different crops on *Pseudomonas solanacearum* populations in tobacco soils. 1988. M.C. Engelbrecht
- TK.2142/19/3/5: An investigation to find an effective dosage of chlorpicrin mixture for the control of the bacterial wilt organisms in tobacco soils. 1988. D.A. de Villiers
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- TK.2142/19/3/7: An investigation of methods for determining *Pseudomonas solanacearum* populations in tobacco soils. 1988. M.C. Engelbrecht

• *Pests/Plae*

- TK.2142/20/1/6: The time, leaf position and impact of boll worm attacks on tobacco. 1987. E.G. Eulitz
- TK.2142/20/2/5: The effect of nematocides on different nematode species and populations on tobacco. 1985. E.R. van Biljon
- TK.2142/20/2/7: The refinement of infra-red detection techniques (for remote sensing) to determine nematode infestation in tobacco for improved farm management. 1985. M.S. Greeff
- TK.2142/20/2/8: Survey of parasitic nematodes which occur in association with tobacco. 1986. M.S. Greeff
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- TK.2142/20/3/2: Investigation to alternative host plants for the tobacco spidermite. 1987. C.L.N. du Toit

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- TK.2142/21/1/1: Chemical weed control in flue-cured tobacco plantings. 1968. C.R. Nolte
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• *Crop science/Gewaskunde*

- TK.2142/30/1/6: Chemical control of suckers on tobacco. 1968. C.R. Nolte
- TK.2142/30/3/1: The effect of harvesting practices, handling of picked leaves and colouring schedule on quality and chemical composition of Oriental tobacco. 1989. M.C. Dippenaar
- TK.2142/30/3/2: Evaluation of plant population and nitrogen fertilisation for Oriental tobacco cultivars and breeding lines. 1989. R.M. Zipp
- TK.2142/30/4/1: The effect of seedbed covers on germination of Oriental tobacco seed. 1989. D. Meyer
- TK.2142/30/4/2: The effect of the hardening process of tobacco seedlings on the growth and development of Oriental tobacco. 1989. D. Meyer
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- TK.2142/30/5/1: The influence of N fertilisation, topping and spacing on the production of orange tobacco with different cultivars and breeding lines. 1989. G.J. Malan

• *Water requirements/Waterbehoefte*

- TK.2142/31/1/3: The effect of irrigation and dripper spacing on growth and yield on flue-cured tobacco. 1988. C. Barnard
- TK.2142/31/1/4: The effect of irrigation on growth and development of flue-cured tobacco. 1988. C. Barnard
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- TK.2142/31/3/2: The role of plant water status on leaf quality in tobacco under different environmental conditions. 1989. G.J. Malan

• *Technology/Tegnologie*

- TK.2142/52/1/1: Influence of drying schedules upon chemical and physical properties of burley tobacco. 1989. C.J. Steenkamp

• *Chemistry/Chemie*

- TK.2142/53/1/4: Determination of the sugar and starch contents of tobacco during the growing season. 1988. M.C. Minnaar

SUNDRY AGRONOMIC CROPS/DIVERSE AKKERBOUGEWASSE

• *Crop science/Gewaskunde*

- GG.2143/30/1/1: Introduction of rice breeding material. 1980. J.J. Coetzee
- GG.2143/30/1/2: Evaluation of cultivars for agricultural value and adaptability. 1980. J.J. Coetzee

CHICORY/SIGOREI

• *Nutrition/Voeding*

- D.2144/05/1/1: The fertilisation of chicory on an Oakleaf-Limpopo. 1981. R.S. Marr

- *Upgrading/ Veredeling*

D.2144/07/1/1: The selection of chicory. 1975. R.S. Marr

- *Pathology/ Patologie*

TK.2144/19/1/1: Determination of the causal organism(s) of black rot in chicory. 1985. G.C. Prinsloo

- *Pests/ Plae*

TK.2144/20/1/1: Preliminary survey of parasitic nematode genera in chicory. 1985. R.J. van Wyk

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- *Crop science/ Gewaskunde*

D.2144/30/1/1: Chicory seed production. 1975. R.S. Marr

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BIOTECHNOLOGY RESEARCH/BIOTEGNOLOGIESE NAVORSING

Cell biology/Selbiologie

MONOCOTYLEDONS/EENSAADLOBBIGES

- *Physiology/ Fisiologie*

BP.2211/03/1/1: Monocotyledons: callus en cell culture techniques for maize. 1989. B.R. Woodward

DICOTYLEDONS/TWEESAADLOBBIGES

- *Physiology/ Fisiologie*

BP.2212/03/1/1: Dicotyledons: anther culture techniques for groundnuts. 1990. J.A. Brink

BP.2212/03/22/1: Dicotyledons: somatic hybridisation techniques for *Tabacum*. 1990. E.Y. Reinten

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- *Upgrading/ Veredeling*

BP.2212/07/8/2: Dicotyledons: selection for resistance to *Phytophthora parasitica* var. *nicotianae* in tobacco. 1990. E.M. Kritzinger

BP.2212/07/10/1: Dicotyledons: selection for resistance to *Streptomyces scabies* in potatoes. 1991. M.M. Slabbert

BP.2212/07/17/1: Dicotyledons: utilisation of protoclonal variation in potatoes. 1989. E.Y. Reinten

Molecular biology/Molekulêre biologie

MONOCOTYLEDONS/EENSAADLOBBIGES

- *Genetics/Genetika*

- BP.2221/06/2/1: Monocotyledons: identification and isolation of genes for cold tolerance in *Panicum maximum*. 1990. M.M. O'Kennedy

DICOTYLEDONS/TWEESAADLOBBIGES

- *Genetics/Genetika*

- BP.2222/06/1/1: Dicotyledons: identification and isolation of structural genes in agronomical crops. 1990. D. Oelofse
- BP.2222/06/1/2: Dicotyledons: identification and isolation of genes for drought tolerance in cotton. 1990. A. van der Mescht
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- BP.2222/06/3/1: Dicotyledons: identification and isolation of genes for drought tolerance in potatoes. 1989. A. van der Mescht
- BP.2222/06/3/2: Dicotyledons: identification and isolation of genes for *Fusarium* resistance in potatoes. 1989. C.F. de W. Ries
- BP.2222/06/3/3: Dicotyledons: identification and isolation of genes for resistance against *Streptomyces scabies* in potatoes. 1990. H.A.R. Petrick
- BP.2222/06/3/6: Dicotyledons: identification and isolation of genes for coat protein of watermelon mosaic virus-2 and watermelon mosaic virus-m. 1990. G.C. Bothma
- BP.2222/06/7/1: Dicotyledons: identification and isolation of genes for resistance to *Colletotrichum* in lucerne. 1990. A.L. Kotze

- *Pathology/Patologie*

- BP.2222/19/1/1: Dicotyledons: differentiation of *Fusarium oxysporum* isolates that cause potato dry rot, tuber end rot and wilt on the basis of vegetative compatibility and pathogenicity. 1989. S.L. Venter
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DEPARTMENTAL GENE BANKS/DEPARTEMENTELE GENEBAKKE

Horticulture research/Tuinbounavorsing

VEGETABLES AND POTATOES/GROENTE EN AARTAPPELS

- *Crop science/Gewaskunde*

- GS.2321/30/1/2: Collection and description of genetic resources of potatoes. 1988. D.C.A. Hoffman

- *Upgrading/Veredeling*

WW.2327/07/1/1: Maintenance and expansion of a grape gene bank. 1988. F.S. de Villiers

HORTICULTURE RESEARCH/TUINBOUNAVORSING

Tuber crops/Knolgewasse

POTATOES/AARTAPPELS

- *Physiology/Fisiologie*

GS.2411/03/1/1: The influence of calcium on the cell wall and cell structure of potato tubers. 1983. Marianne W. Venter

GS.2411/03/1/3: Development and evaluation of techniques for determination of heat and cold tolerance of potatoes. 1987. E. Beetge

GS.2411/03/1/5: Influence of the post-harvest calcium dip of potato tubers on the keeping quality. 1990. M.V. Venter

GS.2411/03/2/1: In vitro storage techniques of disease-free mother material of potatoes. 1983. J.L.F. Dutrieux

GS.2411/03/2/2: Pollen culture in potatoes as a breeding technique. 1983. J.A. Brink

GS.2411/03/4/1: The evaluation of techniques to determine the physiological age of potato seed tubers. 1987. B.J. Pieterse

- *Nutrition/Voeding*

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- *Upgrading/Veredeling*

GS.2411/07/1/1: Breeding of improved potato cultivars. 1983. A.F. Visser

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GS.2411/07/3/1: Genetic studies to broaden the genetic base of potato cultivars. 1975. A.F. Visser

GS.2411/07/4/1: Upgrading of potatoes: utilisation of normal and/or induced protocol variation. 1986. J.M. Lindeque

- GS.2411/07/4/2: Upgrading of potatoes: utilisation of callus and cell suspension culture techniques as a method of selection. 1988. J.M. Lindeque
- GS.2411/07/5/1: Breeding of potatoes cultivars for tolerance to root-knot nematodes (*Meloidogyne* spp.). 1987. P.J. Steyn

• *Pathology/Patologie*

- GS.2411/19/1/2: Study and control of common scab on potatoes. 1978. B.W. Young
- GS.2411/19/1/4: Ecology and control of black scurf on potatoes. 1979. B.W. Young
- GS.2411/19/1/5: Control of silver scurf on potatoes. 1985. L. Marais
- GS.2411/19/1/6: Study of silver scurf on potatoes. 1985. L. Marais
- GS.2411/19/1/8: Study of anthracnose on potatoes. 1985. L. Marais
- GS.2411/19/1/9: Study of *Fusarium* spp. concerned with dry rot and stemrot of potatoes. 1985. D.J. Theron
- GS.2411/19/1/10: Evaluation of fungicides to control *Fusarium* dry rot of potatoes. 1987. D.J. Theron
- GS.2411/19/2/3: Bacterial wilt disease of potatoes: survival of the pathogen. 1988. A.E. Swanepoel
- GS.2411/19/2/4: Identification of the pathogens causing Erwinia wilt of potatoes. 1989. S. Serfontein
- GS.2411/19/2/5: Evaluation of ELISA kits for *Pseudomonas solanacearum* in potatoes. 1989. A.E. Swanepoel
- GS.2411/19/3/4: Effect of tuber stimulation on the detection of potato viruses in tomatoes. 1987. P.J. Prins
- GS.2411/19/3/7: Potato virus Y in potatoes: identification and characterisation of strains. 1983. G.J. Thompson
- GS.2411/19/3/10: Occurrence and epidemiology of potato leaf roll virus and beet western yellows and their strains in potatoes. 1987. G.J. Thompson

• *Pests/Plae*

- GS.2411/20/1/1: Biological studies of black maize beetle in potatoes. 1984. J.M.I. Donaldson
- GS.2411/20/1/2: Bio-ecological studies of the potato snout beetle. 1984. J.M.I. Donaldson
- GS.2411/20/3/1: Evaluation of techniques to determine the tolerance of potatoes to *Meloidogyne* nematodes. 1987. P.J. Steyn

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- GS.2411/30/1/1: Phase-2 evaluation of adaptability of promising potato breeding lines in different areas. 1963. J.L. Schoeman
- GS.2411/30/1/2: Phase-2 evaluation of advanced breeding lines and imported cultivars in different areas. 1979. J.L. Schoeman
- GS.2411/30/1/3: Introduction and preliminary evaluation of foreign potato cultivars. 1973. A.F. Visser
- GS.2411/30/1/4: Evaluation of commercial acceptability of promising potato breeding lines and imported cultivars. 1987. D.C.A. Hoffman
- GS.2411/30/2/12: Optimal plant population for potatoes under irrigation. 1986. J.J. Nel
- GS.2411/30/2/13: The efficiency of diffused light storage as compared to cold storage of potatoes. 1987. E. Beetge
- GS.2411/30/3/1: Maintenance and multiplication of genetic resources of potatoes. 1987. D.C.A. Hoffman

• *Water requirements/Waterbehoefies*

- GS.2411/31/1/2: Water requirements of potatoes and the influence of water regime on biomass and quality. 1987. J.M. Steyn

Vegetables/Groente

TOMATOES/TAMATIES

- *Physiology/Fisiologie*

- GS.2421/03/1/1: Anther culture of tomatoes. 1987. J.A. Brink
GS.2421/03/1/2: Establishment and embryogenesis of cell cultures of tomatoes. 1987. R.P. de Villiers

- *Upgrading/Veredeling*

- GS.2421/07/1/1: Breeding and selection of market tomatoes. 1975. S.E. Bosch
GS.2421/07/1/2: Breeding and selection of processing tomatoes. 1975. S.E. Bosch

- *Pathology/Patologie*

- GS.2421/19/2/3: Epidemiology of bacterial spot and speck on tomato seedlings. 1989. J.J. Serfontein
GS.2421/19/3/1: Identification and characterisation of the potyvirus group in tomatoes. 1981. G.J. Thompson
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- *Pests/Plae*

- GS.2421/20/1/1: A study of plant parasitic eelworm on tomatoes. 1981. K.C. Daiber
GS.2421/20/1/2: Bio-ecological studies of *Liriomyza trifolii* on tomatoes. 1985. M.C. Bolton

- *Crop science/Gewaskunde*

- GS.2421/30/1/1: Evaluation of new market tomato cultivars and breeding lines. 1975. H.A. Dafel
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- GS.2421/31/1/2: Water requirements of processing tomatoes. 1986. H.A. Dafel

ONIONS/UIE

- *Upgrading/Veredeling*

- GS.2422/07/2/1: The breeding of F₁-hybrid onions. 1983. Elsa van der Klashorst

- *Pathology/Patologie*

- GS.2422/19/1/1: Study of *Pyrenochaeta terrestris*, the pink root pathogen of onions. 1983. J.F. Ferreira
GS.2422/19/1/2: Post-harvest decay of onions by *Aspergillus niger*: epidemiology and occurrence. 1987. S.P. Naude

GS.2422/19/1/5: Seed-borne diseases of onions: *Alternaria* blotch. 1990. B.H. Boelema

- *Crop science/Gewaskunde*

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GS.2422/30/2/2: Planting density of onions. 1986. A.G. Comrie
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GS.2422/30/3/1: Maintenance and multiplication of genetic resources of onions. 1987. P.O. Stork
GS.2422/30/3/2: Collection and description of genetic resources of onions. 1986. Elsa van der Klashorst

COLE CROPS/KOOLGEWASSE

- *Physiology/Fisiologie*

GS.2423/03/1/1: The influence of seed treatments on the germination/physiology of cole crops: cabbage. 1984. B.H. Boelema

- *Pests/Plae*

GS.2423/20/1/1: Study of *Heterodera schachtii* in cole crops. 1987. K.C. Daiber

- *Crop science/Gewaskunde*

GS.2423/30/1/2: Cole crops: phase-II evaluation of cauliflower cultivars and breeding lines. 1975. C.P.J. Coetzee
GS.2423/30/1/3: Cole crops: phase-II evaluation of broccoli cultivars and breeding lines. 1981. W.P. Stapelberg
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GS.2423/30/2/4: Collection and description of genetic resources of cole crops: broccoli. 1987. A.A. van den Berg

ROOT CROP VEGETABLES/WORTELAGTIGE GROENTE

- *Anatomy/Anatomie*

GS.2424/02/1/1: Root crop vegetables: anatomical studies of root development in sweet potatoes. 1986. C.P. du Plooy

- *Physiology/Fisiologie*

GS.2424/03/1/1: Root crop vegetables: physiology of storage root initiation and growth in sweet potatoes. 1986. C.P. du Plooy

- *Upgrading/Veredeling*

GS.2424/07/1/1: Root crop vegetables: breeding and selection of sweet potatoes. 1976. C. Bester
GS.2424/07/1/2: Root crop vegetables: breeding and selection of industrial sweet potatoes. 1975. C. Bester

- *Pathology/ Patologie*

GS.2424/19/1/1: Root crop vegetables: virus diseases of root crop vegetables: sweet potatoes. 1981. G.J. Thompson

- *Crop science/ Gewaskunde*

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GS.2424/30/4/2: Collection and description of genetic resources of root crop vegetables: sweet potatoes. 1987. C. Bester

GS.2424/30/4/3: Maintenance and multiplication of genetic resources of root crop vegetables: carrots. 1987. P.O. Stork

GS.2424/30/4/5: Maintenance and multiplication of genetic resources of root crop vegetables: beetroot. 1987. D.C.A. Hoffman

GS.2424/30/4/6: Collection and description of genetic resources of root crop vegetables: beetroot. 1987. Elsa van der Klashorst

- *Water requirements/ Waterbehoefies*

GS.2424/31/1/1: Water requirements of root crop vegetables: carrots. 1982. P.F. Nortje

LEGUME VEGETABLES/PEULGROENTE

- *Upgrading/ Veredelings*

GS.2425/07/2/1: Legume vegetables: breeding and selection of green peas. 1975. S.E. Bosch

GS.2425/07/2/2: Legume vegetables: breeding and selection of dry peas. 1977. S.E. Bosch

- *Pathology/ Patologie*

GS.2425/19/1/1: Legume vegetables: a study of halo blight of green beans. 1975. B.H. Boelema

- *Crop science/ Gewaskunde*

GS.2425/30/2/2: Legume vegetables: phase-II evaluation of dry pea cultivars and breeding lines. 1977. C. Bester

GS.2425/30/4/1: Maintenance and multiplication of genetic resources of legume vegetables: green beans. 1987. P.O. Stork

GS.2425/30/4/2: Collection and description of genetic resources of legume vegetables: green beans. 1987. A.A. van den Berg

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GS.2425/30/4/4: Collection and description of genetic resources of legume vegetables: peas. 1987. C.E. Rappard

GS.2425/30/5/1: An evaluation of the efficiency and phytotoxicity of herbicides on green beans. 1981. H.A. Dafel

VINE CROPS/RANKGEWASSE

• Upgrading/Veredeling

- GS.2426/07/1/1: Vine crop vegetables: breeding and selection of pumpkins. 1976. S.E. Bosch
GS.2426/07/1/2: Vine crop vegetables: breeding and selection of muskmelon. 1976. J.J.B. van Zijl

• Crop science/Gewaskunde

- GS.2426/30/1/1: Vine crop vegetables: evaluation of pumpkin cultivars and breeding lines. 1977. C. Bester
GS.2426/30/1/2: Vine crops: phase-II evaluation of muskmelon cultivars and breeding lines. 1976. Elsa van der Klashorst
GS.2426/30/2/1: Weed control studies in pumpkin and squashes. 1982. H.A. Dafei
GS.2427/30/2/3: The effect of high phosphate application on lettuce growth and leaf composition. 1991. H.A. Dafei
GS.2426/30/3/1: Maintenance and multiplication of genetic resources of vine crops. 1987. D.C.A. Hoffman
GS.2426/30/3/2: Collection and description of genetic resources of vine crops: pumpkins. 1987. Elsa van der Klashorst
GS.2426/30/3/3: Collection and description of genetic resources of vine crops: muskmelon. 1987. A.G. Comrie
GS.2426/30/3/4: Collection and description of genetic resources of vine crops: watermelons. 1987. C. Bester

SUNDRY VEGETABLES/DIVERSE GROENTE

• Physiology/Fisiologie

- GS.2427/03/1/2: Sundry vegetables: anther culture of asparagus (*Asparagus officinalis*). 1989. J.A. Brink
GS.2427/03/2/1: Sundry vegetables: in vitro propagation of garlic. 1990. C.C. van Rhyn

• Crop science/Gewaskunde

- GS.2427/30/2/1: Sundry vegetables: cultivation studies with lettuce. 1983. C.P. du Plooy
GS.2427/30/2/2: Sundry vegetables: optimisation of lettuce production in the Tala Valley. 1989. H.A. Dafei
GS.2427/30/2/3: The effect of high phosphate application on lettuce growth and leaf composition. 1991. H.A. Dafei
GS.2427/30/3/1: Maintenance and multiplication of genetic resources of sundry vegetables: garlic. 1987. D.C.A. Hoffman
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CHICORY/SIGOREI

• Upgrading/Veredeling

- GS.2428/07/1/1: Breeding of chicory. 1989. C. Bester

- *Pathology/Patologie*

- GS.2428/19/1/2: Evaluation of chicory cultivars for resistance to black rot. 1987. J.F. Ferreira
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- *Technology/Tegnologie*

- GS.2428/52/1/1: Calibration of Nir equipment for the determination of fibre content in chicory. 1988. M. Biemond
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Flowers and ornamental plants/Blomme en sierplante

PROTEAS

- *Physiology/Fisiologie*

- GS.2431/03/2/1: Rapid multiplication of proteas in vitro: *Leucospermum*. 1986. B.A. Rugge
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 GS.2431/03/2/3: Rapid multiplication of proteas in vitro: *Protea*. 1987. D.I. Ferreira

- *Upgrading/Veredeling*

- GS.2431/07/1/2: Hybridisation studies with proteas: genus *Protea*. 1985. G.J. Brits
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 GS.2431/07/1/5: Upgrading of proteas as pot plants: genus *Protea*. 1987. G.J. Brits
 GS.2431/07/2/1: Hybridisation studies with proteas: genus *Leucospermum*. 1985. G.J. Brits
 GS.2431/07/2/2: Upgrading of proteas as pot plants: genus *Leucospermum*. 1987. G.J. Brits
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 GS.2431/07/3/2: Upgrading of proteas as pot plants: genus *Leucadendron*. 1987. G.J. Brits
 GS.2431/07/4/1: Upgrading of proteas as pot plants: genus *Serruria*. 1987. G.J. Brits

- *Pests/Plae*

- GS.2431/20/1/2: Bio-ecological studies of insects on proteas. 1986. J.H. Coetzee
 GS.2431/20/1/3: Proteas: insects associated with *Protea magnifica* and *Protea laurifolia*. 1988. M.G. Wright
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- *Crop science/Gewaskunde*

- GS.2431/30/1/2: Evaluation of protea cultivars and selections. 1978. G.J. Brits
 GS.2431/30/2/3: Reproduction of proteas by means of grafting and budding. 1987. D.G. Malan
 GS.2431/30/2/4: Proteas: maximising seed germination percentage in *Leucospermum*. 1988. G.J. Brits
 GS.2431/30/3/2: Cultivation of proteas in inert media. 1987. D.G. Malan
 GS.2431/30/3/3: An investigation into lime tolerant rootstock for proteas. 1987. D.G. Malan

- GS.2431/30/4/1: Maintenance and multiplication of genetic resources of proteas. 1987. G.C. van den Berg
- GS.2431/30/4/2: Collection and description of genetic resources of proteas: genus *Protea*. 1986. G.C. van den Berg
- GS.2431/30/4/3: Collection and description of genetic resources of proteas: genus *Leucospermum*. 1986. G.C. van den Berg
- GS.2431/30/4/4: Collection and description of genetic resources of proteas: genus *Leucadendron*. 1986. G.C. van den Berg
- GS.2431/30/4/5: Collection and description of genetic resources of proteas: genus *Serruria*. 1986. G.C. van den Berg
- GS.2431/30/4/6: Collection and description of genetic resources of proteas: genus *Mimetes*. 1986. G.C. van den Berg
- GS.2431/30/5/2: Proteas: influence of short day cycles on flower induction of *Leucospermum* cv. Red Sunset. 1987. D.G. Malan
- GS.2431/30/5/3: Proteas: influence of flower induction during different times of the year on the time of inflorescence development of *Leucospermum* cv. Red Sunset. 1987. D.G. Malan
- GS.2431/30/5/4: Proteas: influence of partial induction on the development of distal axillary buds on *Leucospermum* cv. Red Sunset shoots. 1987. D.G. Malan
- GS.2431/30/5/5: Prevention of shoot growth cessation in *Leucospermum*. 1987. D.G. Malan
- GS.2431/30/5/6: Proteas: delaying inflorescence development of *Leucospermum*. 1987. D.G. Malan
- GS.2431/30/5/7: Proteas: manipulation of flowering time - improving inflorescence quality in *Leucospermum*. 1988. D.G. Malan
- GS.2431/30/5/8: Proteas: night interruption and the prevention of induction of flower *Leucospermum* cv. Red Sunset. 1987. D.G. Malan
- GS.2431/30/6/1: Proteas: influence of daylength on inflorescence development of *Serruria florida*. 1988. D.G. Malan
- GS.2431/30/7/1: Proteas: inflorescence initiation and development in the genus *Protea*. 1987. D.G. Malan

POT PLANTS/POTPLANTE

• *Physiology/Fisiologie*

- GS.2432/03/1/1: Rapid multiplication of bulb flower pot plants in vitro: *Lachenalia*. 1982. J.G. Janse van Rensburg
- GS.2432/03/1/3: Rapid multiplication of bulb flower pot plants in vitro: *Amaryllis*. 1987. M. de Bruyn
- GS.2432/03/1/4: Rapid multiplication of bulb flower pot plants in vitro: *Crinum*. 1987. M.M. Slabbert
- GS.2432/03/3/1: Bulb flower pot plants: multiple flower formation of *Lapeirousia*. 1988. E. Louw
- GS.2432/03/4/1: Bulb flower pot plants: in vitro storage of *Lachenalia* shoot tips. 1989. E. Louw

• *Upgrading/Veredelings*

- GS.2432/07/1/1: Bulb flower pot plants: breeding and selection of *Lachenalia*. 1974. F.L. Hancke
- GS.2432/07/1/2: Pot plants: breeding and selection of intergeneric hybrids of *Amaryllidaceae*. 1987. A.F. Coertze
- GS.2432/07/2/1: Cytogenetical study of bulb flower pot plants: *Lachenalia*. 1983. F.L. Hancke

• *Pathology/Patologie*

- GS.2432/19/1/1: Identification of the virus diseases of bulb flower pot plants: *Lachenalia*. 1981. J.T. Burger

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- GS.2432/30/2/1: Bulb flower pot plants: manipulation of the flowering and growth period of *Lachenalia*. 1984. L. Meyer
- GS.2432/30/2/2: Pot plants: in vivo vegetative and corm increasing techniques. 1986. L. Meyer
- GS.2432/30/3/1: Maintenance and multiplication of genetic resources of bulb flower pot plants. 1987. P.J. Klesser
- GS.2432/30/3/2: Collection and description of genetic resources of bulb flower pot plants: *Lachenalia*. 1987. F.L. Hancke
- GS.2432/30/3/3: Collection and description of genetic resources of bulb flower pot plants: *Amaryllidaceae*. 1987. A.F. Coertze

CUT FLOWERS/SNYBLOMME

- *Physiology/Fisiologie*

- GS.2433/03/1/3: Rapid multiplication of bulbous cut flowers in vitro: *Gladiolus*. 1983. M. de Bruyn
- GS.2433/03/2/1: Embryo culture studies on bulbous cut flowers: *Gladiolus*. 1984. J.G. Janse van Rensburg
- GS.2433/03/2/3: Embryo culture studies on bulbous cut flowers: *Nerine*. 1987. J.G. Janse van Rensburg
- GS.2433/03/2/4: Embryo culture studies on bulbous cut flowers: *Cyrtanthus*. 1987. J.G. Janse van Rensburg
- GS.2433/03/3/1: In vitro plant generation of bulbous cut flowers: *Nerine*. 1990. J.H. Coetzee
- GS.2433/03/3/2: In vitro plant generation of bulbous cut flowers: *Gladiolus*. 1990. J.H. Coetzee
- GS.2433/03/3/3: In vitro plant generation of bulbous cut flowers: *Ornithogalum*. 1990. J.H. Coetzee

- *Nutrition/Voeding*

- GS.2433/05/1/1: Nutritional needs of bulbous cut flowers: *Ornithogalum*. 1984. A.F. Coertze

- *Upgrading/Veredeling*

- GS.2433/07/1/1: Bulbous cut flowers: breeding and selection of *Ornithogalum*. 1978. F.L. Hancke
- GS.2433/07/1/2: Bulbous cut flowers: breeding and selection of *Gladiolus*. 1983. S.D. Verryn
- GS.2433/07/2/1: Cytogenetical studies of bulbous cut flowers: *Gladiolus*. 1986. S.D. Verryn
- GS.2433/07/2/2: Cytogenetical studies of bulbous cut flowers *Amaryllidaceae* *Nerine*. 1991. C.M. Oelofse
- GS.2433/07/3/1: Sterility studies of bulbous cut flowers: *Nerine*. 1986. G. Sorour

- *Pathology/Patologie*

- GS.2433/19/3/1: Identification of the virus diseases of certain bulbous cut flowers: *Ornithogalum*. 1981. J.T. Burger
- GS.2433/19/3/2: Virus elimination by means of chemotherapy and meristem culture in bulbous cut flowers: *Ornithogalum*. 1984. B.M. Vcelar

- *Pests/Plae*

- GS.2433/20/4/2: Shrub-like cut flowers: chemical control of *Pachnoda sinuata* on roses. 1987. J.M.I. Donaldson

- *Integrated control/Geïntegreerde beheer*

GS.2433/23/1/2: Occurrence and integrated control of Western Flower thrips on cut flowers. 1990 J.H. Coetzee

- *Crop science/Gewaskunde*

GS.2433/30/2/2: Cut flowers: manipulation of the flowering and growth period of *Gladiolus*. 1986. L. Meyer

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GS.2433/30/3/1: Maintenance and multiplication of genetic resources of bulbous cut flowers. 1987. P.J. Klesser

GS.2433/30/3/2: Collection and description of genetic resources of bulbous cut flowers: *Ornithogalum*. 1987. F.L. Hancke

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GS.2433/30/4/1: Bulbous cut flowers: growth and flower development studies of *Gladiolus*. 1990. J.H. Coetzee

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FYNBOS

- *Physiology/Fisiologie*

GS.2435/03/1/1: Determination of germination requirements of fynbos seed: *Helichrysum vesitum*. 1987. D.G. Malan

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- *Pests/Plae*

GS.2435/20/1/1: Fynbos: interactions between *Audouinia capitata* and associated insects. 1988. M.G. Wright

GS.2435/20/1/2: Biology, ecology and control of borers associated with fynbos plant species. 1990. M.G. Wright

- *Crop science/Gewaskunde*

GS.2435/30/1/1: Growth and development patterns of fynbos: *Helipterum eximium*. 1987. D.G. Malan

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Pome and stone fruits/Kern- en steenvrugte

APPLES/APPELS

- *Physiology/Fisiologie*

VV.2441/03/2/3: A test for the occurrence of specific replant diseases of apples. 1982. H.J. van Zyl

VV.2441/03/2/5: Development of a mycorrhizal inoculum for apples. 1991. M.W. Venter

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- VV.2441/03/5/3: Ethylene synthesis as a maturity index for apples. 1987. S.J. van Eeden
- VV.2441/03/6/7: The influence of nitrogen and potassium nutrition on the synthesis of organic acids and the incidence of bitterpit in apples. 1983. J.F. de Villiers
- VV.2441/03/6/10: The mechanism of action of rest-breaking agents in apples. 1986. M.S. North
- VV.2441/03/6/11: Control of delayed foliation of apples. 1986. M.S. North
- VV.2441/03/6/13: Stem en russetting of apples. 1986. H.J. van Zyl

• *Nutrition/Voeding*

- VV.2441/05/2/6: Seasonal distribution of nitrogen and potassium fertilisation for apple trees. 1985. C.M. Olivier
- VV.2441/05/2/7: Effect of nitrogen potassium and phosphate fertilisation practices on the fruit quality of apples. 1985. C.M. Olivier

• *Upgrading/Veredeling*

- VV.2441/07/1/2: Breeding of apple cultivars resistant to scab. 1977. J.H. Acker
- VV.2441/07/1/7: Development of Granny Smith apple plants from callus and single cells for use in mutation breeding. 1985. R.E. Pieterse

• *Pathology/Patologie*

- VV.2441/19/1/2: Investigation of curative and protective characteristics of existing and new fungicides for apple scab control. 1981. W.F.S. Schwabe
- VV.2441/19/1/9: Nature and extent of core rot of apples in the Western Cape. 1988. S.L. de Kock
- VV.2441/19/2/2: Etiology of blister bark of apples. 1987. E.L. Mansveldt
- VV.2441/19/2/3: Genomic fingerprints of pseudomads strains on apples. 1989. E.L. Mansveldt
- VV.2441/19/2/4: Bacteriophages of Pseudomads from apple trees. 1981. E.L. Mansvelt
- VV.2441/19/2/5: Introduction and expression of foreign genes in apples and other fruits. 1990. H.J. du Plessis

• *Pests/Plae*

- VV.2441/20/1/3: Bionomics of codling moth on apples. 1982. T.L. Blomefield
- VV.2441/20/1/4: Insecticide bioassays on banded fruit weevil on apples. 1989. B.N. Barnes
- VV.2441/20/1/5: Performance of plant protection chemicals against insect pests on apples. 1989. P.L. Swart
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- WW.2463/31/1/1: Studies with regard to irrigation and cultivation practices for raisin grapes (sultana) on a Dundee soil of the Lower Orange River area. 1983. J.L. van Zyl

Oenology/Wynkunde

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• *Taxonomy/Taksonomie*

- WW.2471/01/1/2: Mass spectrometric characterisation of cellular fatty acid profiles of wine yeast strains. 1987. O.P.H. Augustyn

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- WW.2471/08/1/2: Determination of the oenological properties of wine yeasts. 1982. J.J. Venter
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Citrus and subtropical crops/Sitrus- en subtropiese gewasse

CITRUS/SITRUS

• *Physiology/Fisiologie*

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- SS.2481/05/1/2: Macro- and micro-element fertilisation of citrus in the Citrusdal area. 1971. S.F. du Plessis
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- SS.2481/07/1/10: Cryopreservation of citrus seed and pollen. 1990. K. Carstens
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• *Physiology/Fisiologie*

- SS.2482/03/1/1: Development of tissue culture techniques for the production of embryonic callus and protoplasts in pineapples. 1984. M. Fitchet

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- SS.2482/05/1/1: Nutritional requirements of pineapples in the Eastern Cape Region. 1972. D.B. Dalldorf
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- SS.2482/30/1/6: Plant density and spacing for smooth Cayenne pineapples. 1986. E.R. Dalldorf
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- SS.2482/52/1/2: Extending the shelf-life of pineapples. 1989. P.C. Fourie
- SS.2482/52/1/3: Temperature requirements of Queen pineapples during overseas shipment. 1990. D.H. Swarts

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- *Physiology/Fisiologie*

- SS.2483/03/1/5: Radioimmunoassay to determine the hormonal status of alternate bearing avocado trees. 1981. J.G.M. Cutting
- SS.2483/03/3/2: Physiological indicators for the prediction of final harvest date of avocados. 1985. J.P. Bower

- *Nutrition/Voeding*

- SS.2483/05/1/1: Macro- and micro-element requirements of avocados. 1970. T.J. Koen

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- SS.2483/07/1/2: Identification of avocado cultivars by beans of restriction fragment length polymorphism (RFLP). 1991. E.A. Lewis

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- *Technology/Tegnologie*

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DIVERSE SUBTROPICAL FRUITS/ALLERLEI SUBTROPISCHE VRUGTE

• *Anatomy/Anatomie*

- SS.2485/02/1/4: Diverse subtropical fruits: phenology in relation to guava. 1987. R.J. du Preez
- SS.2485/02/1/5: Effect of rootstock and climate factors on fruit morphogenesis in granadilla. 1987. A.J. Joubert
- SS.2485/02/1/6: Propagation biology of diverse subtropical fruit: the influence of boron on fruit set of mangoes. 1989. W. Schroeder

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- SS.2485/03/2/2: Diverse subtropical fruits: development of a shoot tip grafting technique for granadillas. 1985. M. Nel
- SS.2485/03/2/4: Diverse subtropical fruits: clonal propagation of papayas in vitro. 1985. G.W. de Winnaar
- SS.2485/03/2/6: Diverse subtropical fruits: clonal propagation of guavas in vitro. 1988. M. Fitchet
- SS.2485/03/2/7: Suspension culture of litchi. 1990. J.E. Vos
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- SS.2485/19/1/4: Diverse subtropical fruits: control of Malelane dieback in guavas. 1982. N.M.G. Grech
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- SS.2485/19/1/8: The epidemiology of fungal diseases of mango blossoms. 1991. M.H. Joubert

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- SS.2485/20/1/4: The role of mango bud mite *Aceria mangiferae* (Sayed) in mango misformation. 1990. T.I. Labuschagne
- SS.2485/20/1/5: Studies on the mango scale *Aulacaspis tubercularis* Newstead. 1991. T.I. Labuschagne

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OTHER SUBTROPICAL CROPS/ANDER SUBTROPIESE GEWASSE

• *Physiology/Fisiologie*

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• *Nutrition/Voeding*

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- SS.2486/30/1/2: Alternative trellising systems of pepper in the Levubu area. 1990. A.C. Nel
- SS.2486/30/3/1: Diverse subtropical crops: vegetative propagation of *Coffea canephora* and *C. arabica*. 1989. B. Snijder
- SS.2486/30/3/2: Other subtropical crops: seed propagation of *Coffea canephora* and *C. arabica*. 1989. B. Snijder
- SS.2486/30/4/1: Other subtropical crops: evaluation of tea clones. 1991. C. Fraser

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- SS.2486/33/1/1: Climate manipulation for other subtropical crops: ginger. 1987. T. Anderson

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- *Nutrition/Voeding*

- SS.2491/05/1/1: Macro- and micro-element requirements of macadamia nuts. 1968. R.A. Abercrombie

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- *Crop science/Gewaskunde*

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- SS.2491/30/1/5: Clonal propagation of macadamia nut trees. 1991. P.J. Muller
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- SS.2491/30/2/2: High density planting of macadamia nuts. 1990. E.M. Wiid
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- VV.2491/30/1/1: Second phase evaluation of almond cultivars in the Western Province. 1971. E.J. van Zyl
- VV.2491/30/1/2: Nuts: evaluation of pecan nut cultivars in the High- and Middleveld of Transvaal. 1983. T.K. Haulik
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Radioisotopes/Radioisotope

RADIOISOTOPY/RADIOISOTOPIE

- *Chemistry/Chemie*

- VV.24101/53/1/2: Radiochemical separation of ²⁸Mg and ²⁸Al in a radioisotope generator. 1983. H. Gerber

Sundry horticultural crops/Diverse tuinbougewasse

HORTICULTURAL CROPS/TUINBOUGEWASSE

- *Physiology/Fisiologie*

- GS.24111/03/2/1: Horticultural crops: study of recalcitrant seeds. 1988. J.T. Meynhardt

- *Nutrition/Voeding*

- VV.24111/05/1/2: Horticultural crops: nitrogen, potassium and boron fertilisation of olives. 1981. K. Bothma
- VV.24111/05/1/3: Horticultural crops: seasonal uptake of mineral nutrients by olive trees. 1987. J.F. de Villiers
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- GS.24111/30/3/1: Evaluation of different cultivars and breeding lines of the horticultural crop guayle under dryland conditions. 1981. H.A. Dafel
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- VV.24111/30/1/3: Horticultural crops: evaluation of olive rootstocks in the Paarl and Robertson areas. 1982. C. Costa
- VV.24111/30/1/11: Horticultural crops: evaluation of prickly pear cultivars and selection for the Transvaal. 1987. T.K. Haulik
- VV.24111/30/2/1: Horticultural crops: planting and training systems for olives. 1982. C. Costa
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- VV.24111/30/10/2: Horticultural crops: artificial rest breaking of kiwi fruit by climatological and chemical manipulation. 1984. G.C. Linsley-Noakes
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VV.24111/52/3/1: Horticultural crops: effect of physical variables during fermentation and drying on rooibos tea quality. 1990. E. Joubert

- *Chemistry/Chemie*

VV.24111/53/1/1: Horticultural crops: chemical composition of kiwi fruit. 1988. J.A.G. van Rhyen

VV.24111/53/2/1: Horticultural crops: chemical changes during processing of rooibos tea. 1990. E. Joubert

VV.24111/53/2/2: Horticultural crops: isolation and identification of phenolic components of rooibos tea. 1991. D. Ferreira

PLANT PROTECTION RESEARCH/PLANTBESKERMINGSNAVORSING

Entomology/Zoology/Insektekunde/Dierkunde

INSECTS/INSEKTE

- *Taxonomy/Taksonomie*

PB.2511/01/1/1: Collection of southern African insects. 1910. G.L. Prinsloo

PB.2511/01/1/5: Taxonomy of parasitic wasps, Chalcidoidea. 1970. G.L. Prinsloo

PB.2511/01/1/7: Taxonomy of Neuroptera. 1977. M.W. Mansell

PB.2511/01/1/9: Taxonomy of Hymenoptera Aculeata. 1978. C.D. Eardly

PB.2511/01/1/10: Taxonomy of Cicadellidae of southern Africa. 1973. G.L. Prinsloo

PB.2511/01/1/11: Taxonomy and distribution of weevils (Curculionidae) in southern Africa. 1985. R.G. Oberprieler

PB.2511/01/1/12: Taxonomy and distribution of Aphidoidea and Coccoidea in southern Africa. 1985. I.M. Millar

PB.2511/01/1/13: Taxonomy and distribution of the Chrysomeliodea in southern Africa. 1989. E. Grobbelaar

- *Pests/Plae*

PB.2511/20/1/1: Migratory locust control by aerial spray application. 1981. H.D. Brown

PB.2511/20/1/2: The outbreak dynamics of the African migratory locust. 1981. H.D. Brown

PB.2511/20/1/4: Insects: the optimum volume rate for effective control of the brown locust. 1990. C.F. Kriel

PB.2511/20/2/1: Insects: predators of the harvester termite, *Hodotermes mossambicus*. 1984. Anette Nel

PB.2511/20/2/4: Aspects of the population dynamics of the harvester termite *Hodotermes mossambicus* in the Bloemfontein district. 1985. Anette Nel

PB.2511/20/2/5: The effect of termites on the natural veld in the Bloemfontein district. 1986. Anette Nel

- *Biological control/Biologiese beheer*

PB.2511/22/2/1: The use of natural enemies to control stalk borers in cereal crops. 1978. A.R. Kfir

- PB.2511/22/3/1: Development of a computerised data system for insect pests and their natural enemies. 1983. H. van Hamburg
- PB.2511/22/3/2: Handling and regulation of imported natural enemies of insect pests under quarantine conditions. 1983. H. van Hamburg

• *Integrated control/Geïntegreerde beheer*

- PB.2511/23/1/2: The effect of pesticides applied under field conditions against *H. armiger* on natural enemies and red spider mite. 1978. J.D. Mohr
- PB.2511/23/1/5: The use of natural enemies to control *H. armiger*. 1978. H. van Hamburg
- PB.2511/23/3/1: Evaluation of insecticides against insects which attack the spineless cactus. 1983. M.W. Pretorius

NEMATODES/AALWURMS

• *Taxonomy/Taksonomie*

- PB.2512/01/1/1: Collection of nematodes in southern Africa. 1962. Esther van den Berg
- PB.2512/01/1/3: Taxonomy of root-knot nematodes, *Meloidogyne* spp. 1981. K.P.N. Kleynhans
- PB.2512/01/1/4: Taxonomic study of the South African Longidoridae. 1976. Esther van den Berg

MITES/MYTE

• *Taxonomy/Taksonomie*

- PB.2513/01/1/1: Collection of mites of agricultural importance. 1959. Magdalena K.P. Meyer
- PB.2513/01/1/2: Taxonomy and biology of predacious mites in South Africa. 1962. E.A. Ueckermann
- PB.2513/01/1/3: Taxonomy of free-living Acari in South African soils. 1976. Magdalena K.P. Meyer

• *Integrated control/Geïntegreerde beheer*

- PB.2513/23/1/1: Integrated control of spider mite species of agronomic crops. 1986. N.C.J. Basson

SPIDERS/SPINNEKOPPE

• *Taxonomy/Taksonomie*

- PB.2514/01/1/1: Taxonomy of agriculturally important spiders. 1976. A.S. Dippenaar

HONEY-BEE/HEUNINGBY

• *Nutrition/Voeding*

- PB.2516/05/1/2: Nectar and pollen flora of South Africa. 1969. M.F. Johannsmeier
- PB.2516/05/1/3: The effect of *Drosophila* spp. on the nectar supply of eucalyptus flowers. 1983. A.P. du Toit

• *Pathology/Patologie*

- PB.2516/19/1/1: Diseases of the adult honey-bee. 1976. B. Buys

- *Pests/Plae*

PB.2516/20/1/1: Control of the Argentine ant at bee hives. 1988. B. Buys

- *Pollination/Bestuiwing*

PB.2516/29/1/1: The effect of honey-bees on sunflower pollination. 1985. A.P. du Toit

STORED GRAIN/OPGEBERGDE GRAAN

- *Pests/Plae*

PB.2518/20/1/4: The biology, distribution and identification of the genera *Trogoderma* and *Phradonoma* (Coleoptera: Dermestidae) in stored grain in South Africa. 1987. M. Jonsson

PB.2518/20/1/5: Integrated control of moth pests of stored grain in bags. 1990. J. Schmidt

FOREST AND TIMBER/BOSBOME EN TIMMERHOUT

- *Pests/Plae*

PB.2519/20/1/1: The biology, fungal associations and control of bark beetles on pine trees. 1979. G.D. Tribe

PB.2519/20/1/3: The biology, pest status and control of the black pine aphid. 1977. N.J. van Rensburg

PB.2519/20/1/4: Forest and timber: the biology of the pine woolly aphid. 1982. A.J. Urban

PB.2519/20/1/7: Forest and timber: biology and control of beetle pests of *Eucalyptus* spp. 1984. G.D. Tribe

PB.2519/20/1/8: The biology of insect pests of furniture timber plantations. 1986. J.F. Morrison

Plant pathology/Microbiology/Plantpatologie/Mikrobiologie

FUNGI/SWAMME

- *Taxonomy/Taksonomie*

PB.2521/01/1/1: Identification of diverse fungi. 1973. A.P. Baxter

PB.2521/01/1/7: Fungi: expansion and maintenance of the National Collection of Fungi: culture collection. 1989. C. Roux

PB.2521/01/1/8: Fungi: expansion, maintenance and computerisation of the National Collection of Fungi: dried collection (PREM). 1989. A.P. Baxter

PB.2521/01/2/1: Taxonomy of Ascomycetes: ontogeny of certain loculoascomycetes. 1988. E.J. van der Linde

PB.2521/01/3/1: Fungi: conidrogenesis of the Coelomycetes in South Africa. 1989. C. Roux

PB.2521/01/4/1: Fungi: morphology and taxonomy of *Ganaderma* species in South Africa. 1989. A.P. Baxter

PB.2521/01/5/1: Fungi: taxonomy of *Penicillium* species in South Africa. 1989. A.L. Schutte

PB.2521/01/6/1: Fungi: an annotated list of rusts in South Africa. 1989. M. van Reenen

PB.2521/01/7/1: Fungi: chemotaxonomy of *Pythium* spp. 1990. W.J. Botha

PB.2521/01/7/2: Chemotaxonomy of *Phytophthora* spp. 1990. W.J. Botha

• *Mycology/Mikologie*

- PB.2521/11/1/1: Examination of diverse feeds for toxigenic fungi. 1978. C. Roux
 PB.2521/11/1/2: Role of toxigenic fungi in the occurrence of hepatogenous photosensitivity in livestock. 1971. C. Roux

• *Pathology/Patologie*

- PB.2521/19/1/2: Seed-borne fungi of dry beans. 1982. A.P. Baxter
 PB.2521/19/5/2: Factors affecting sporulation infection and disease development by the fungus *D. dematioidea*. 1985. Sharon L. von Broembsen
 PB.2521/19/5/3: Control of pin cushion blight caused by the fungus *D. dematioidea*. 1986. Sharon L. von Broembsen
 PB.2521/19/6/2: Biology of fungi of the genus *Rhizoctonia*. 1987. A.J.L. Phillips
 PB.2521/19/7/4: Fungi: the role of *Fusarium* in crop rotation systems in the Winter Rainfall Region. 1990. S.C. Lamprecht
 PB.2521/19/7/5: Fungi: a comparative study of *Fusarium graminearum* Gr. I and *F. graminearum* Gr. 2. 1990. S.C. Lamprecht
 PB.2521/19/7/6: Fungi: the etiology of the wilt pathogen, *Fusarium oxysporum* F. sp. *Melonis* in the melon producing areas of South Africa. 1991. W. Schreuder
 PB.2521/19/7/7: Fungi: determination of *Fusarium oxysporum* F. sp. *melonis* races in South Africa. 1991. W. Schreuder
 PB.2521/19/9/1: Fungi: etiology of *Colletotrichum* diseases of different crops in South Africa with special reference to legumes in the pasture conversion scheme. 1990. S.H. Koch
 PB.2521/19/9/2: Fungi: epidemiology of *Colletotrichum* diseases of different crops in South Africa with special reference to legumes in the pasture conversion scheme. 1990. S.H. Koch
 PB.2521/19/11/1: Fungi: the isolation and identification of *Pythium* species with special reference to *Pythium* species involved with damping-off of lucerne seedlings. 1990. S. Denman
 PB.2521/19/11/2: Fungi: environmental factors associated with *Pythium* damping-off lucerne seedlings. 1990. S. Denman
 PB.2521/19/11/3: Fungi: the evaluation of possible control methods of *Pythium* damping-off of lucerne. 1990. S. Denman

BACTERIA/BAKTERIEë

• *Nitrogen fixation/Stikstofbinding*

- PB.2522/09/1/1: Testing of commercial bacterial inoculants for legumes. 1967. J.L. Staphorst
 PB.2522/09/1/2: Selection of *Rhizobium* bacteria for inoculants. 1968. C.J. Otto
 PB.2522/09/1/9: Application of nitrogen fixing bacterial inoculants to legumes through irrigation systems. 1983. J.L. Staphorst
 PB.2522/09/1/10: Development of immunological methods for quality control of legume inoculants containing bacteria. 1985. H.H. Lochner
 PB.2522/09/1/11: Bacteria: possible utilisation of liquid *Rhizobium* inoculant. 1985. C.J. Otto
 PB.2522/09/1/12: Bacteria: investigation of problems experienced with inoculation of pasture legumes. 1985. J.L. Staphorst
 PB.2522/09/1/13: Bacteria: investigation of problems experienced with inoculation of grain legumes. 1985. J.L. Staphorst
 PB.2522/09/1/15: Bacteria: role of lectins in the *Rhizobium*-legume symbiosis. 1986. I.J. Law

● *Pathology/Patologie*

- PB.2522/19/1/1: Identification and control of bacterial pathogens of crops from various regions and institutes. 1979. C.C.P.R. Deschodt
- PB.2522/19/1/2: Elimination of seed-borne bacterial pathogens from bean seed. 1974. C.C.P.R. Deschodt
- PB.2522/19/1/3: Bacteria: identification and elimination of bacterial pathogens from soybean cultivars. 1985. C.C.P.R. Deschodt
- PB.2522/19/1/4: Bacteria: identification and elimination of bacterial pathogens from *Brassica* sp. 1985. C.C.P.R. Deschodt
- PB.2522/19/1/6: Bacteria: survey of bacterial pathogens on pasture legumes and determination of host range. 1986. C.C.P.R. Deschodt

● *Biological control/Biologiese beheer*

- PB.2522/22/1/1: Bacteria: isolation, identification and biotyping of *Agrobacterium* spp. from plants and soil. 1985. F.G.H. van Zyl
- PB.2522/22/1/2: Bacteria: the determination of agrocin production and sensitivity of local pathogenic and non-pathogenic *Agrobacterium* species. 1985. F.G.H. van Zyl
- PB.2522/22/1/3: Bacteria: the evaluation of D286 as control strain for crown gall where K84 appears to be unsuccessful. 1985. F.G.H. van Zyl
- PB.2522/22/1/4: Bacteria: the role of competition and specificity of the plant cell binding sites in the biological control of crown gall. 1985. J.L. Staphorst
- PB.2522/22/1/5: Bacteria: the role of agrocin in the biological control of crown gall. 1985. J.L. Staphorst
- PB.2522/22/1/6: Bacteria: the determination of factors in the Boland that is responsible for the possible suppression of crown gall on grapevine. 1985. F.G.H. van Zyl

VIRUSES/VIRUSSE

● *Virology/Viologie*

- PB.2523/12/1/8: Expansion and maintenance of a plant virus anti-serum bank. 1990. G. Pietersen
- PB.2523/12/1/9: Investigation into plant virus problems identified by the agricultural sector. 1990. G. Pietersen
- PB.2523/12/1/10: Detection and identification viruses of legumes. 1989. G. Pietersen
- PB.2523/12/1/11: A molecular study of a South African isolate of soybean mosaic virus as a model of the potyvirus group. 1990. G. Pietersen

FOREST AND TIMBER/BOSBOME EN TIMMERHOUT

● *Pathology/Patologie*

- PB.2525/19/1/6: Integrated control of forest tree diseases. 1983. A.E. Lundquist
- PB.2525/19/2/1: Forest and timber: pathogenicity host range and spread of *Verticicladiella* spp. causing root diseases of pines. 1985. M.J. Wingfield
- PB.2525/19/5/1: Forest and timber: host range, pathogenicity and distribution of *Mycosphaerella* needle disease of pines. 1986. M.J. Wingfield
- PB.2525/19/10/2: Forest and timber: routine diagnosis of forest tree diseases in the Cape Province and Natal. 1985. M.J. Wingfield

PASTURE CROPS/WEIDINGSGEWASSE

• Pathology/Patologie

- PB.2526/19/1/9: Pasture crops: seed-borne fungal pathogens and disease transmission by seed of *Medicago* spp. 1986. S.C. Lamprecht
- PB.2526/19/1/10: Pasture crops: survival and infection of *Fusarium avenaceum* on annual *Medicago* spp. 1986. S.C. Lamprecht
- PB.2526/19/1/11: Pasture crops: the role of *Fusarium* in a wheat-medic crop rotation system. 1986. S.C. Lamprecht
- PB.2526/19/1/13: Pasture crops: assessment of disease resistance of cultivated lucerne cultivars to above and below ground pathogens in South Africa. 1986. S.C. Lamprecht

Electron microscopy/Elektronmikroskopie

ELECTRON MICROSCOPY/ELEKTRONMIKROSKOPIE

• Technology/Tegnologie

- PB.2541/52/1/1: Preparation and examination of biological specimens by electron microscopy. 1979. H.J. van Tonder

Weed research/Onkruidnavorsing

WEEDS/ONKRUIDE

• Physiology/Fisiologie

- PB.2551/03/1/1: Physiology of veld invader weeds' seed germination. 1981. P.L. Campbell
- PB.2551/03/2/2: Eco-physiology of jointed cactus (*Opuntia aurantiaca*). 1984. S. Naser

• Chemical control/Chemiese beheer

- PB.2551/21/1/1: Chemical control of the weed jointed cactus (*Opuntia aurantiaca*). 1960. H.G. Zimmermann
- PB.2551/21/1/3: Chemical control of the weed mesquite (*Prosopis* spp.). 1983. G.B. Harding
- PB.2551/21/1/4: Chemical control of alien veld invaders in Natal. 1983. D.J. Erasmus
- PB.2551/21/1/5: Chemical control of invader weeds of localised Eastern Cape areas. 1983. B.D. Viljoen
- PB.2551/21/1/7: Chemical control of important weeds and unwanted plants in plantations. 1988. R.P. Denny
- PB.2551/21/1/8: Chemical control of the weed silver leaf bitterapple (*Solanum elaeagnifolium*). 1988. B.D. Viljoen

• Biological control/Biologiese beheer

- PB.2551/22/1/4: Biological control of the weed prickly pear (*Opuntia ficus-indica*). 1960. H.G. Zimmermann
- PB.2551/22/1/5: Biological control of the weed *Lantana camara*. 1972. C.J. Cilliers
- PB.2551/22/1/6: Biological control of the weeds *Hakea sericea*, *H. gibbosa* and *H. saueolens*. 1972. R.L. Kluge

- PB.2551/22/1/8: Biological control and management of cactus weeds, particularly jointed cactus in South Africa. 1977. S. Naser
- PB.2551/22/1/10: Biological control of the weed *Solanum mauritianum* (bugweed). 1988. S. Naser
- PB.2551/22/1/12: Biological control of the weed silver leaf bitterapple (*Solanum elaeagnifolium*). 1985. H.G. Zimmermann
- PB.2551/22/1/11: Biological control of undesirable Australian *Acacia* weeds. 1988. G.B. Dennill
- PB.2551/22/1/13: Biological control of the weed *Chromolaena odorata* using natural insect enemies. 1988. R.L. Kluge
- PB.2551/22/1/15: Biological control of the weed spear thistle (*Cirsium vulgare*). 1988. D.J.R. Noel
- PB.2551/22/1/16: Biological control of the weed *Prosopis*. 1988. H.G. Zimmermann
- PB.2551/22/1/17: Biological control of important aquatic weeds. 1988. C.J. Cilliers
- PB.2551/22/1/18: Biological control of diverse weeds by means of mites. 1989. C. Creamer
- PB.2551/22/1/18: Biological control of the weed silver leaf bitterapple (*Solanum elaeagnifolium*). 1985. H.G. Zimmermann
- PB.2551/22/2/1: A study of the diseases of some indigenous and exotic weeds which are caused by local pathogens. 1979. M.J. Morris
- PB.2551/22/2/2: Biological control of *Acacia* weeds by means of pathogens. 1982. M.J. Morris
- PB.2551/22/2/5: Biological control of diverse weeds with the aid of pathogens. 1988. M.J. Morris

• *Integrated control/ Geïntegreerde beheer*

- PB.2551/23/1/1: Integrated control of the weed *Opuntia aurantiaca* (jointed cactus). 1986. L. Henderson

• *Plant geography/ Plantgeografie*

- PB.2551/25/1/1: A survey of alien invasive trees and shrubs in the grassland and savanna biomes. 1986. L. Henderson

• *Ecology/ Ekologie*

- PB.2551/27/1/2: Ecology of the weed nassella tussock (*Stipa trichotoma*). 1983. B.D. Viljoen
- PB.2551/27/1/10: Reproductive ecology of the weed *Acacia mearnsii*. 1988. P.J. Pieterse

PESTICIDES/PLAAGDODERS

• *Physiology/ Fisiologie*

- PB.2552/03/1/2: Effect of pesticide breakdown in soils on phytotoxicity. 1984. E.R.I.C. Sandmann
- PB.2552/03/1/3: A study of climatic factors potentiating pesticide phytotoxicity in legumes. 1984. E. van Rensburg
- PB.2552/03/1/5: Determination of the threshold value for and physiological mechanisms of hormone herbicides in vegetable crops. 1988. L.M. Jordaan
- PB.2552/03/1/6: The effect of sub-lethal concentrations phenoxy herbicides on the growth and development of tomato fruit. 1989. F. Zuhlsdorff

• *Biotesting/ Biotoeetsing*

- PB.2552/24/1/2: The use of plant cells and plant tissue culture to determine herbicide concentrations. 1985. J.L. Graaf
- PB.2552/24/2/1: The use of the ELISA technique to determine pesticides with auxin mode of action in plants and water. 1989. F. Zuhlsdorff

• *Technology/Tegnologie*

- PB.2552/52/1/3: Study of physical characteristics of pesticide formulations. 1980. H.A. Abott
- PB.2552/52/1/4: The role of adjuvants in the penetration and effectiveness of pesticides. 1985. L.P. van Dyk
- PB.2552/52/1/5: The role of leaf surfaces in the effectiveness of adjuvants and pesticides. 1986. M.J. York

• *Chemistry/Chemie*

- PB.2552/53/1/4: Pesticide residues in raw vegetables, fruit and animal products. 1977. L.P. van Dyk
- PB.2552/53/1/5: Analysis of pesticides and their residues affecting useful plants. 1983. P. Niewoudt
- PB.2552/53/1/6: Research and improvement of pesticide analysis done by the WGPA. 1984. P.R. de Beer
- PB.2552/53/1/7: Development of confirmation techniques for pesticide residue analysis. 1985. Marelie Krause

ANIMAL PRODUCTION PROMOTION DIEREPRODUKSIEBEVORDERING

ANIMAL PRODUCTION AND ANIMAL PRODUCTS RESEARCH DIEREPRODUKSIE- EN DIEREPRODUKTENAVORSING

Animal production/Diereproduksie

BEEF CATTLE/VLEISBEESTE

- *Reproduction/Reproduksie*

VS.3111/04/1/1: Reproduction in beef cattle: biochemical interrelationships during nutritional stress. 1984. G.W. Kay

- *Upgrading/Veredeling*

VS.3111/07/1/1: Evaluation of beef bulls in upgrading: Bonsmara. 1980. D.J. Bosman

VS.3111/07/1/2: Beef cattle: evaluation of the Roodebos and Wesselsvlei Bonsmara breeding lines. 1982. D.J. Bosman

VS.3111/07/1/3: Upgrading studies on beef cattle - improving fertility by natural selection. 1984. M.M. Scholtz

VS.3111/07/1/6: Upgrading studies on beef cattle: the influence of the simulation of natural selection of body mass and fertility in a large beef breed. 1985. M.M. Scholtz

VS.3111/07/1/8: Upgrading studies on beef cattle - the estimation of brain mass by using head measurements of cattle and rats. 1985. H.E. Theron

VS.3111/07/1/9: Upgrading of beef cattle: genetic relationship between certain production traits on different nutritional and management regimes. 1990. H.E. Theron

DAIRY CATTLE/MELKBEESTE

- *Physiology/Fisiologie*

VS.3112/03/1/1: An investigation into in vitro culture techniques for hormone dependent mammary gland tissue in dairy cattle. 1983. J.P. van Zyl

VS.3112/03/1/3: Influence of lactation and exogenous peptide hormones on the physiology and metabolism of lipogenic precursors. 1985. S.I. van der Walt

- *Nutrition/Voeding*

VS.3112/05/1/3: Ureum in complete diets for dairy cattle. 1982. L.J. Erasmus

VS.3112/05/1/5: Dairy cattle nutrition: establishment of a degradability database. 1985. L.J. Erasmus

VS.3112/05/1/7: Dairy cattle nutrition: strategic protein nutrition of high producing cows. 1985. B. Ferreira

VS.3112/05/1/9: Dairy cattle: the in sacco digestibility of amino acid of UDP in the small intestine. 1987. L.J. Erasmus

VS.3112/05/1/10: Dairy cattle: the effectiveness of yeast culture (YEA SACC) in a complete diet for dairy cattle. 1989. L.J. Erasmus

VS.3112/05/1/11: Dairy cattle: the effect of a combination of an ionophore (monensin) and BST on the productivity of high producing cows. 1990. L.J. Erasmus

- *Genetics/ Genetika*

- VS.3112/06/1/2: Genetic research in dairy cattle: the incidence of DUMPS in Holstein - Friesian cattle and the identification of carrier animals. 1991. A. Swanepoel

- *Upgrading/ Veredelings*

- VS.3112/07/1/3: Milkability and milk quality characteristics in the upgrading of dairy cattle. 1971. J.H. Hofmeyr

- *Management/ Bestuur*

- VS.3112/41/1/1: Biological economic data-analysing service for dairy cattle. 1981. B. Ferreira

MUTTON SHEEP/VLEISSKAPE

- *Nutrition/ Voeding*

- VS.3113/05/1/1: Mutton sheep: sorghum grain as the major feed component in combination with various problem sources in an intensive feedlot system. 1989. J.H.F. Meyer

- *Upgrading/ Veredelings*

- VS.3113/07/1/1: Upgrading of mutton sheep: quantification of genetic and non-genetic components of maternal effects. 1985. J.C. Greeff

WOOLLED SHEEP/WOLSKAPE

- *Reproduction/ Reproduksie*

- VS.3114/04/1/1: Woolled sheep: a comparative study of the reproduction characteristics of ewe lambs for four sheep breeds differing in fecundity. 1989. H.C. Bezuidenhout

- *Upgrading/ Veredelings*

- VS.3114/07/1/1: Skin and fibre characteristics in the upgrading of woolled sheep. 1972. O. Steinhagen
- VS.3114/07/2/1: Upgrading of reproduction characteristics of woolled sheep by means of cross-breeding. 1972. J.H. Hofmeyr
- VS.3114/07/2/2: Upgrading of woolled sheep crosses: evaluation of the Gotlander and its crosses for carpet wool production. 1985. J.C. Greeff
- VS.3114/07/2/3: Evaluation of selected cross-bred woolled sheep under normal farm conditions in co-operation with co-operative workers. 1985. J.C. Greeff

PELT SHEEP/PELSSKAPE

- *Upgrading/ Veredelings*

- VS.3115/07/1/1: Upgrading of pelt sheep - white Karakuls. 1980. J.H. Hofmeyr

PIGS/VARKE

- *Nutrition/ Voeding*

- VS.3119/05/1/5: Pig nutrition: the "ideal protein" requirements of the growing pig. 1984. E.H. Kemm

- VS.3119/05/1/6: Pig nutrition: qualitative and quantitative aspects and implications of wheat as feed source. 1984. F.K. Siebrits
- VS.3119/05/1/12: Digestive physiology and metabolism aspects in animal feeding: lipid metabolism in the vicinity of the break-point in the growth curve of pigs. 1988. J.P. Minnaar
- VS.3119/05/1/13: Pig nutrition: the development of a computer-based pig herd simulation model. 1988. F.K. Siebrits
- VS.3119/05/1/14: Pig nutrition: use of Mobile Nylon Bag Technique (MNBT) on ileorectal anastomosis modified pigs to determine digestible protein and amino acid values at the terminal ileum. 1988. J. Viljoen
- VS.3119/05/1/15: Pig nutrition: the amino acid digestibility of different feedstuffs in the nutrition of the early weaned piglet. 1989. J. Viljoen
- VS.3119/05/1/16: Pig nutrition: determination of the bio-availability of different phosphorus sources. 1990. F.K. Siebrits

• *Upgrading/Veredeling*

- VS.3119/07/1/2: Upgrading of pigs: biochemical genetic typing for identification and parentage control. 1985. A. Swanepoel

CHICKENS/HOENDERS

• *Physiology/Fisiologie*

- VS.31110/03/1/1: The time course of events in post-mortem poultry muscle. 1991. M.J. Belt

• *Nutrition/Voeding*

- VS.31110/05/1/1: Nutrition of laying fowls - influence of calcium on phosphorus requirements. 1977. J.J. Prinsloo
- VS.31110/05/1/3: Nutrition of laying fowls - seasonal energy and protein levels. 1975. F.D.C. Labuschagne
- VS.31110/05/1/5: The use of lupins as feed component in poultry diets. 1987. J.J. Prinsloo
- VS.31110/05/1/6: Evaluation of processing methods of full-fat soybeans in broiler diets. 1988. B.J. Welgemoed
- VS.31110/05/1/7: The use of a high protein sunflower oilcake meal as feed component in poultry diets. 1989. J.J. Prinsloo

• *Upgrading/Veredeling*

- VS.31110/07/1/1: Upgrading of laying fowls - sex-linked feather colour. 1972. J.J. Joubert
- VS.31110/07/1/2: Upgrading of laying fowls - red or gold feather colour. 1971. J.J. Joubert
- VS.31110/07/1/3: Upgrading of laying fowls - combining activity. 1971. J.J. Joubert
- VS.31110/07/1/4: Upgrading of laying fowls - Australorp. 1971. J.J. Joubert
- VS.31110/07/1/5: Upgrading of laying fowls - other breeds. 1972. J.J. Joubert
- VS.31110/07/1/6: Upgrading of laying fowl breeds - New Hampshire control flock. 1976. J.J. Joubert
- VS.31110/07/1/7: Genotype environment interaction in laying fowls - upgrading of laying fowl breeds. 1976. J.J. Joubert
- VS.31110/07/2/1: Upgrading of meat type male line fowls. 1975. J.J. Joubert
- VS.31110/07/2/2: Upgrading of meat type hen line fowls. 1962. J.J. Joubert
- VS.31110/07/2/3: Male and female line genetic control flocks. 1987. J.J. Joubert

- VS.31110/07/2/4: The influence of age of broiler cocks on their semen quality and fertility. 1990. J.J. Viljoen
- VS.31110/07/3/1: Broiler ascites: a study on the nutritional effect of ascorbic acid on the production and mortality of broilers. 1990. D.D. Malan

OTHER POULTRY/ANDER PLUIMVEE

• Nutrition/Voeding

- VS.31115/05/1/1: Nutrient requirement of other poultry - Chinese geese. 1965. J.J. Prinsloo
- VS.31115/05/1/2: Nutrient requirement of other poultry feeding systems - ducks. 1977. M.D. Olver

• Upgrading/Veredelings

- VS.31115/07/1/1: Upgrading of other poultry - Hagedoorn system with ducks. 1965. M.D. Olver

Animal products/Diereprodukte

MEAT/VLEIS

• Norm studies/Normstudies

- VS.3121/50/1/2: Meat production: carcass evaluation - cattle. 1975. J.F. de Bruyn
- VS.3121/50/1/3: Meat production: chilling of beef carcasses. 1976. P.H. Heinze
- VS.3121/50/1/9: Meat production: compensatory growth - cattle. 1982. J.F. de Bruyn
- VS.3121/50/1/11: Meat production: porcine stress syndromes. 1984. P.H. Heinze
- VS.3121/50/1/15: The influence of chilling and other environmental factors on the shelf-life of meat. 1987. G.L. Nortje
- VS.3121/50/1/16: A comparison between the agar impression technique, the modified agar impression technique and the excision technique to determine the bacterial contamination of meat. 1987. S.J. Botha
- VS.3121/50/1/18: Nutritional and quality characteristics of beef. 1988. H.C. Schönfeldt
- VS.3121/50/1/19: Survey of the meat product industry of the Republic of South Africa. 1988. I.B. Zondach
- VS.3121/50/1/21: Meat production: nutritional and quality characteristics of veal. 1989. H.C. Schönfeldt
- VS.3121/50/1/22: Meat production: evaluation of quality characteristics of the *Mm longissimus thoracis et lumborum* obtained from lambs fed on cotton seed or cake with a supplementary diet of either protected fats or grain sorghum. 1989. I.B. Zondach
- VS.3121/50/2/2: Pork and pork production norm studies: the effects of castration and feeding unsaturated oil (sunflower seed) on the fatty acid composition of pig fat (intra- and extra-muscular). 1987. S.M. de Jong
- VS.3121/50/2/3: Pork production and meat norm studies: carcass evaluation of cross-bred pigs. 1987. G.G. Bruwer
- VS.3121/50/2/4: Meat quality characteristics of cross-bred pigs. 1987. P.H. Heinze
- VS.3121/50/2/5: The development of a classification and grading system for pig meat in South Africa. 1987. G.G. Bruwer
- VS.3121/50/2/6: Meat quality characteristics as influenced by genotype, slaughter mass and sex type. 1987. P.H. Heinze
- VS.3121/50/2/7: Pork fat quality characteristics as influenced by genotype, slaughter mass and sex type. 1987. S.M. de Jong

VS.3121/50/2/8: The suitability of carcass meats for processing as influenced by genotype, sex type and slaughter mass. 1987. J.C. Venter

VS.3121/50/2/9: Pork production norm studies: evaluation of sensory characteristics of roasts and processed products as influenced by genotype, sex type and slaughter mass. 1987. I.B. Zondach

VS.3121/50/3/1: Microbiological and technological properties of fresh pork during slaughtering, deboning, vacuum and gas packaging and distribution. 1987. E.M. Scholtz

VS.3121/50/3/2: Evaluation of different packaging systems and their suitability for application in centralised pre-packing of pig meat retail cuts. 1990. E.M. Scholtz

VS.3121/50/4/1: The influence of zinc tannate on sexual development, production and product characteristics of the meat bulls. 1987. P.E. Strydom

VS.3121/50/4/2: Growth manipulation and meat norm studies: the influence of different anabolic growth promoters under intensive conditions on the performance and product characteristics of lambs. 1989. P.E. Strydom

MEAT PRODUCTS/VLEISPRODUKTE

• Norm studies/ Normstudies

VS.3122/50/5/1: The occurrence of *Listeria*, *Salmonella* and *Campylobacter* in meat and meat products on the South African market. 1990. S.M. Vorster

• Technology/ Tegnologie

VS.3122/52/1/1: The optimal utilisation of carcasses and meat condemned on the grounds of being sub-standard, but safe in processed meat products for human consumption. 1990. T. Pietersen

VS.3122/52/1/2: Meat products: the efficiency of an accelerated processing technique for the production of restructured cured ham. 1990. G.L. Nortjé

VS.3122/52/1/3: Meat products: the utilisation of hot processing in the production of bacon. 1990. I Horn

VS.3122/52/1/4: The utilisation of hot-processed pig meat in the manufacture of emulsion products. 1990. J.A. Visser

MILK/MELK

• Microbiology/ Mikrobiologie

VS.3123/08/1/5: Milk: preservation of milk samples for bacterial count tests. 1983. H. Gavron

VS.3123/08/2/4: The presence and influence of facultative anaerobic fecal bacteria in milk and milk products. 1987. D. Wessels

VS.3123/08/2/5: Milk: the occurrence and importance of biofilms in milk pipelines in the dairy industry. 1988. C. Koutzayiotis

VS.3123/08/3/2: The shelf-life of aseptical-packaged pasteurised milk. 1983. J.F. Mostert

VS.3123/08/4/2: Milk: assay of antibiotics. 1983. H. Gavron

• Norm studies/ Normstudies

VS.3123/50/1/1: Somatic cell counts in herd milk. 1988. G.J. Swart

• *Chemistry/Chemie*

- VS.3123/53/1/4: The non-protein nitrogen content of milk in the RSA. 1988. N.H. Robertson
- VS.3123/53/1/5: The relationship between milk protein polymorphism and the production of milk and milk proteins. 1988. D.J. de Lange
- VS.3123/53/2/1: Discolourisation of UHT-milk. 1981. B.G. Venter
- VS.3123/53/4/1: Natural and added iodine in milk. 1981. D. Wessels
- VS.3123/53/4/2: Regional and seasonal tendencies and sources of contamination of pesticides in milk products. 1985. L.E. Smit

DAIRY PRODUCTS/SUIWELPRODUKTE

• *Microbiology/Mikrobiologie*

- VS.3124/08/1/1: Dairy products: a genetic study of the group *N. streptococci*. 1981. H. Gavron
- VS.3124/08/1/3: Dairy products: bacterial content of air in dairy factories. 1983. K. Radmore
- VS.3124/08/1/5: The long chain fatty acid composition as an aid in the identification of the lactic acid streptococci used in commercial starter cultures in South Africa. 1988. H.B. Muller
- VS.3124/08/1/8: The bacteriological composition of commercial cheese starters used in South Africa. 1987. F.S. Botha
- VS.3124/08/2/2: Dairy products: the influence of non-starter organisms on Cheddar cheese. 1983. A.J. Kruger
- VS.3124/08/2/4: Dairy products: the incidence and practical importance of psychrotrophic Enterobacteriaceae in milk and dairy products. 1987. A.L. Malan
- VS.3124/08/3/5: Dairy products: the evaluation of pathogenic bacteria in milk and cheese. 1983. H. Gavron
- VS.3124/08/3/6: Dairy products: screening of South African raw milk for the presence of *Listeria monocytogenes*. 1988. T. Wnorowski

• *Norm studies/Normstudies*

- VS.3124/50/1/1: Dairy products: production and quality of butter in South Africa. 1981. J.J. du Toit

• *Technology/Tegnologie*

- VS.3124/52/1/1: Dairy products: technique studies in the concentration of whey and skim milk by ultrafiltration. 1983. T.E.H. Downes
- VS.3124/52/1/2: The use of products recovered by ultrafiltration in dairy products. 1972. T.E.H. Downes
- VS.3124/52/1/5: Dairy products: the development of a low-energy dairy spread with favourable spreadability. 1982. T.E.H. Downes
- VS.3124/52/1/6: Dairy products: demineralisation, processing and utilisation of cheese whey. 1982. A.P. Potgieter
- VS.3124/52/1/10: Hydrolysis of lactose in cheese whey for use in dairy products or other foods. 1984. T.E.H. Downes
- VS.3124/52/1/11: Dairy products: the manufacture of cold water instant full-cream milk powder on a two-stage spray dryer. 1985. T.E.H. Downes

• *Chemistry/Chemie*

- VS.3124/53/3/4: Dairy products: the identification of milk proteins in other foods. 1983. B.G. Venter

- VS.3124/53/3/7: Dairy products versus processed oils as fat-energy source: the disturbance of the metabolism of all cis-linoleic acid by the transforms as measured by growth of broiler chicks. 1984. L.D. Nourse
- VS.3124/53/3/8: Dairy products versus processed oils as fat-energy source: the disturbance of the metabolism of all cis-linoleic acid by the transforms as measured by uncontrolled cell proliferation in tissue cultures. 1984. L.D. Nourse
- VS.3124/53/3/9: The incidence of heavy metals in dairy products. 1985. D.J.W. Bester
- VS.3124/53/3/10: The role that intake of fermented dairy products can play in the recovery of disorders in carbohydrate and lipid metabolism as induced by diet. 1990. D.J. de Lange

Supporting animal research/Ondersteunende veekundige navorsing

ANIMALS/DIERE

• *Reproduction/Reproduksie*

- VS.3133/04/1/3: Animal production: comparative study of the pellet and straw freezing methods of sheep semen by means of the zona-free hamster ovum sperm penetration assay. 1989. H. Hattingh
- VS.3133/04/2/1: Farm animal embryo manipulation: in vitro fertilisation of sheep using immature follicular oocytes and fresh semen. 1991. S. Frylinck
- VS.3133/04/2/2: Farm animal embryo - manipulation: borine in vitro fertilisation using immature abattoir oocytes and frozen semen: 1991. E.J. Marais
- VS.3133/04/3/1: Sheep semen manipulation: upgrading the sperm quality evaluation system. 1991. A.S. Faure

• *Nutrition/Voeding*

- VS.3133/05/1/9: Feed intake in the nutrition of farm animals - growth studies with beef steers under production conditions. 1984. J.P. Campher
- VS.3133/05/1/12: Feed intake in the nutrition of farm animals: predicting the voluntary feed intake of South African roughages for growing sheep and cattle. 1988. J.P. Pienaar
- VS.3133/05/1/13: The influence of growth manipulation by means of dietary energy concentration on feedlot parameters of beef cattle. 1991. N. Slabbert
- VS.3133/05/2/8: Protein nutrition: factors influencing the efficiency of microbial protein synthesis in the rumen. 1988. A. Kistner
- VS.3133/05/2/9: Protein nutrition: *Geotrichum candidum* as single cell protein for monogastric animals. 1988. F.J. Nell
- VS.3133/05/3/4: Digestive physiology and metabolism aspects in the feeding of farm animals - glucose production. 1975. J.G. van der Walt
- VS.3133/05/3/12: Digestive physiology and metabolism aspects in the feeding of farm animals - bacterial growth, Na⁺ and K⁺. 1980. R.I. Mackie
- VS.3133/05/1/13: The influence of growth manipulation by means of dietary energy concentration on feedlot parameters of beef cattle. 1991. N. Slabbert
- VS.3133/05/3/18: Digestive physiology and metabolism aspects in the feeding of farm animals: regulation and control of proteases in pure cultures of rumen bacteria. 1984. E. Strydom
- VS.3133/05/3/19: Animals: influence of lactation and nutrition on the metabolism of lipogenic precursors. 1985. J.G. van der Walt
- VS.3133/05/3/20: Digestive physiology and metabolism aspects in animal feeding: partitioning of ruminal acetate and propionate between lipogenesis and gluconeogenesis, respectively in sheep. 1986. M.J. Linington

- VS.3133/05/3/21: Digestive physiology and metabolism aspects in animal feeding - peptide transport and utilisation by rumen bacteria. 1986. K. Westlake
- VS.3133/05/3/23: Digestive physiology and metabolism aspects in animal feeding - development of an in vitro method for evaluating protein digestibility. 1987. P.H. Henning
- VS.3133/05/3/24: Digestive physiology and metabolism aspects in animal feeding: ruminal microbial yield during in vitro incubation of grain mixtures. 1987. P.H. Henning
- VS.3133/05/3/25: Digestive physiology and metabolism aspects in animal feeding: evaluation of acetate clearance rate as an index of growth rate and lipogenesis in lambs fed roughage-based diets. 1987. P.B. Cronje
- VS.3133/05/3/27: Digestive physiology and metabolism aspects in animal feeding - the relationship between rumen microbial growth efficiency and energy supply pattern in vitro. 1988. P.H. Henning
- VS.3133/05/3/28: Digestive physiology and metabolism aspects in animal feeding - evaluation of protected fats for inclusion in ruminant diets. 1988. P.B. Cronje
- VS.3133/05/3/30: Digestive physiology and metabolism aspects in the feeding of farm animals: changes in blood composition associated with the stress of fasting in cattle. 1989. J.P.C. Greyling
- VS.3133/05/3/31: Digestive physiology and metabolism aspects in the nutrition of farm animals; role of synergistic relationships between rumen bacterial species in the degradation of plant cell walls. 1990. A Kistner
- VS.3133/05/3/32: Digestive physiology and metabolism aspects in animal feeding: the influence of rate and synchronisation of nitrogen and energy supply on rumen parameters and microbial growth efficiency. 1990. P.H. Henning
- VS.3133/05/4/4: Crop residues of by-products for animal nutrition - pigs and poultry. 1982. J. Viljoen
- VS.3133/05/4/7: Evaluation and upgrading of crop residues and fibrous industrial waste and by-products as feed source for ruminants. 1988. R. Meeske
- VS.3133/05/6/5: Dietary components in feeds for animal feeding: whole maize grain. 1984. J.P. Campher
- VS.3133/05/6/6: Dietary components in feeds for animal feeding: combinations of energy sources. 1985. P.H. Henning
- VS.3133/05/6/7: Dietary components in feeds for animal feeding: water-reconstituted grain sorghum in fattening diets for beef steers. 1985. N. Slabbert
- VS.3133/05/6/8: Dietary components in feeds for animal feeding: the influence of grain softness on the utilisation of whole maize by beef steers. 1985. N. Slabbert
- VS.3133/05/6/9: Dietary components in feeds for animal feeding: ammoniated grain sorghum in fattening diets for beef steers. 1987. N. Slabbert
- VS.3133/05/6/10: Dietary components in feeds for animal feeding: the utilisation of whole grain from different maize cultivars in fattening diets of beef steers. 1988. N. Slabbert

• *Genetics/Genetika*

- VS.3133/06/1/4: Genetic aspects of blood typing in farm animals. 1969. S.J. du Plessis.
- VS.3133/06/1/5: Genetic production models for farm animals - milk production. 1977. C.Z. Roux
- VS.3133/06/1/6: Laboratory animals in genetic studies: efficiency of feed utilisation. 1978. M.M. Scholtz
- VS.3133/06/1/9: Genetic aspects of karyotyping in farm animals. 1978. N.D. Nel
- VS.3133/06/1/10: Laboratory animals in genetic studies: milk production estimation techniques - rats. 1982. M.M. Scholtz
- VS.3133/06/1/11: The genetic maintenance of small animal populations and the effect of in-breeding on production characteristics. 1982. J.C. Greeff
- VS.3133/06/1/12: Genetic studies on farm animals: preparation of monospecific anti-sera against lymphocyte antigens for investigation into the immune system of cattle. 1985. J. Bester

• *Upgrading/ Veredelng*

- VS.3133/07/1/1: Upgrading studies on indigenous animals - maintenance, evaluation and improvement of indigenous Sanga cattle. 1982. M.M. Scholtz
- VS.3133/07/1/2: Upgrading studies on indigenous animals - cytogenetic studies on Nguni cattle. 1982. N.D. Nel
- VS.3133/07/1/3: Upgrading of animals: the evaluation of highly fertile sheep - breeds and strains in crosses. 1982. J.C. Greeff
- VS.3133/07/1/5: Animals: genetic aspects of protein and enzyme polymorphism in sheep and goats. 1985. M.C. Reid
- VS.3133/07/1/6: Upgrading of animals: production models and statistical methods for the breeding of farm animals. 1986. C.Z. Roux

Biotechnology/Animal science/Biotegnologie/Veekunde

BIOTECHNOLOGY/BIOTEGNOLOGIE

• *Upgrading/ Veredelng*

- VS.3141/07/1/1: Biotechnological research for the upgrading of farm animals: the production of monozygotic twins using embryo splitting. 1986. N.D. Nel
- VS.3141/07/1/2: Biotechnological research for the upgrading of farm animals: genome mapping by restriction fragment length polymorphisms in livestock. 1987. N.D. Nel
- VS.3141/07/1/3: Biotechnological research for the upgrading of farm animals' DNA pattern (fingerprinting) as an aid in parentage studies. 1990. E.J. Harris
- VS.3141/07/1/4: Biotechnological research for the upgrading of farm animals: DNA finger printing of sheep. 1991. J.E. Weermans
- VS.3141/07/1/5: Biotechnological research for the upgrading of farm animals - a study of mitochondrial DNA of indigenous cattle breeds. 1991. S.C. Filter

VETERINARY RESEARCH/VEEARTSENYKUNDIGE NAVORSING

Pathological investigations/Patologiese ondersoeke

PATHOLOGICAL INVESTIGATIONS/PATOLOGIESE ONDERSOEKE

• *Pathology/ Patologie*

- OP.3211/19/1/1: Diagnostic pathological investigations into mortalities of animals through macro- and microscopical techniques. 1981. J.A.W. Coetzer
- OP.3211/19/1/2: Diagnostic investigations into mortalities through electron microscopical techniques. 1981. L. Prozesky
- OP.3211/19/2/8: Pathological investigations: toxicology, clinical pathology and pathology of *Cestrum laevigatum* poisoning in sheep and cattle. 1985. J.J. van der Lugt
- OP.3211/19/2/9: The documentation of the toxicological chemical, chemical-pathological and pathological aspects of *Crotalaria sparioides* poisoning in rabbits and cattle. 1986. J.J. van der Lugt
- OP.3211/19/2/10: Pathological investigations: electron microscopic studies of platelets from lambs infected with Rift Valley fever virus and Wesselsbron disease virus. 1986. J.A.W. Coetzer

- OP.3211/19 2/11: Toxicological, pathophysiological and pathological aspects of *Galenia africana* poisoning in sheep. 1986. J.J. van der Lugt
- OP.3211 19/2 12: Pathological investigations: the citology and treatment of keratoconjunctivitis in sheep. 1990. J. Vorster

Food hygiene/Voedselhigiëne

ANIMAL FOODS/DIERLIKE VOEDSELS

• *Pathology/Patologie*

- OP.3221/19/1/1: Animal foods: diagnosis of mastitis as a herd problem. 1981. W.H. Giesecke
- OP.3221/19/1/2: Animal foods: microscopical investigation of the teat tip and canal at different stages of udder development. 1982. I.M. Clayden
- OP.3221/19/1/3: Animal foods: lacteal levels of glucose and frequencies of subclinical mastitis and other udder conditions. 1981. W.H. Giesecke
- OP.3221/19/1/5: Animal foods: the effect of teat dipping on subclinical udder conditions in dairy cows milked by a machine. 1982. W.H. Giesecke
- OP.3221/19/1/7: Animal foods: normal bacterial flora on bovine udders as affected by age, breed and season. 1979. Anette M. Durand
- OP.3221/19/1/9: Animal foods: interlaboratory standardisation of somatic cell counts in cows' milk in the RSA. 1983. W.H. Giesecke
- OP.3221/19/1/10: Animal foods: the development of the methodology for an investigation of primary prostaglandins and thromboxanes in the normal and pathological udder secretion. 1985. Z.E. Kowalski
- OP.3221/19/1/11: Animal foods: a methodological investigation of the lipoxigenase products of arachidonic acid in normal and pathological udder secretions and tissue homogenates. 1985. Z.E. Kowalski
- OP.3221/19/1/12: Animal foods: determination of ketones in bovine milk by headspace gaschromatography. 1989. H. Winterbach
- OP.3221/19/1/13: The role and significance of catecholamines in bovine udder health. 1989. J.H. du Preez
- OP.3221/19/1/14: The role and significance of reducing sugars relative to catecholamines in blood and milk of dairy cattle. 1989. J.H. du Preez
- OP.3221/19/3/1: Animal foods: potentially pathogenic micro-elements in animal feeds. 1981. Anette M. Durand
- OP.3221/19/3/4: The use of bacterial adenosinetriphosphate (ATP) analysis for the determination of the bacteriological quality of animal feeds. 1985. S.M. Payze

• *Technology/Tegnologie*

- OP.3221/52/2/1: Animal foods: differentiation of the species origin of different meat types. 1983. W.H. Giesecke

Toxicological investigations/Toksikologiese ondersoeke

TOXIC SUBSTANCES/TOKSIESE STOWWE

• *Toxicology/Toksikologie*

- OP.3231/18/1/1: Diagnostics of poisoning of animals by toxic substances. 1981. T.S. Kellerman

- OP.3231/18/2/1: The role of fungi, plants and toxic substances in the aetiology and pathogenesis of photosensitivity. 1971. T.S. Kellerman
- OP.3231/18/2/4: Evaluation of the efficacy of medical and industrial activated charcoals in the prophylaxis and treatment of plant poisonings and mycotoxicoses. 1984. T.S. Kellerman
- OP.3231/18/2/5: Salinomycin poisoning in horses. 1985. P.W. Nel
- OP.3231/18/2/6: Toxic substances: pathogenesis and early diagnosis of gousiekte. 1987. N. Fourie
- OP.3231/18/2/7: Neonatal effects of diplodiosis on livestock. 1988. T.S. Kellerman
- OP.3231/18/2/8: Toxic substances: an investigation into the use of pyrodoxine and its metabolites for the treatment of *Albizia* toxicoses. 1989. B. Gummow

Internal parasite investigations/Interne-parasietondersoeke

HELMINTHS/HELMINTE

- *Taxonomy/Taksonomie*

- OP.3241/01/1/1: Identification of helminths and investigation of definite host ranges. 1983. E.L. Visser
- OP.3241/01/1/2: The taxonomy and incidence of helminths of the Cape hyrax (*Procacia capensis*). 1983. E.L. Visser

- *Pests/Plae*

- OP.3241/20/1/1: Helminths: diagnosis of unknown internal parasite phenomena. 1981. J.A. van Wyk
- OP.3241/20/2/1: Helminths: immunology and serology of cysticercosis of cattle and pigs. 1970. E.L. Visser
- OP.3241/20/2/5: Helminths: epidemiology of tapeworms of ruminants. 1982. E.L. Visser
- OP.3241/20/2/6: Helminths: incidence and treatment of *Stilesia globipunctata* infestation in South Africa. 1983. E.L. Visser
- OP.3241/20/3/1: Helminths: reinfestation of cattle with bilharzia. 1969. J.A. van Wyk
- OP.3241/20/3/2: Helminths: influence of temperature on the development of the larval stages of *Fasciola* spp. 1979. R.M.R. Alves
- OP.3241/20/3/3: Helminths: development of *Fasciola* spp. of cattle and sheep in various definitive hosts. 1978. R.M.R. Alves
- OP.3241/20/3/4: Helminths: pathological physiology of *Schistosoma matthee* infestation of sheep and cattle. 1969. J.A. van Wyk
- OP.3241/20/3/5: Helminths: epidemiology of paramphistomiasis. 1981. J.A. van Wyk

- *Chemical control/Chemiese beheer*

- OP.3241/21/1/1: Chemical control of helminths with special reference to resistance. 1982. J.A. van Wyk

- *Technology/Tegnologie*

- OP.3241/52/1/1: Helminths: long-term storage of pure strains of helminths. 1973. J.A. van Wyk
- OP.3241/52/1/2: Recovery of helminths and/or their ova from animals. 1976. J.A. van Wyk
- OP.3241/52/1/3: Helminths: *ante-mortem* determination of worm loads in animals. 1985. J.A. van Wyk
- OP.3241/52/1/4: Helminths: an investigation of various egg counting methods and the development of quicker *post-mortem* techniques for the determination of internal parasite loads. 1987. F.J. de Villiers

Reproduction investigations/Reproduksie-ondersoeke

INFERTILITY/ONVRUGBAARHEID

• Pathology/Patologie

- OP.3251/19/1/1: Diagnostics of infertility and abortion in animals. 1973. B. Gummow
OP.3251/19/1/2: Serodiagnostics of infertility, abortion and other diseases. 1981. C.C. Williamson
OP.3251/19/2/2: Infertility: immunity to trichomoniasis in cattle. 1981. S. Herr
OP.3251/19/2/3: Infertility: ulcerative dermatosis in sheep. 1981. C.J.V. Trichard
OP.3251/19/2/5: Infertility: bacterial infections of the genitalia of sheep. 1981. B.C. Jansen

Entomological investigations/Entomologiese ondersoeke

EXTERNAL PARASITES/EKSTERNE PARASIEDE

• Entomology/Entomologie

- OP.3261/14/1/1: External parasites: identification and systematics of insects of veterinary importance 1981. E.M. Nevill

• Acarology/Akarologie

- OP.3261/15/1/1: External parasites: identification and systematics of ticks and mites of veterinary importance. 1981. J.B. Walker
OP.3261/15/1/2: External parasites: systematics of the genus *Rhipicephalus*. 1973. J.B. Walker
OP.3261/15/1/3: External parasites: identification and systematics of mites of veterinary importance. 1986. L.C. Jordaan

• Pathology/Patologie

- OP.3261/19/1/1: External parasites: *Cowdria ruminantium* in *Amblyomma hebraeum*. 1977. J.D. Bezuidenhout
OP.3261/19/1/2: External parasites: multiplication of arboviruses in *Culicoides* spp. 1973. E.M. Nevill
OP.3261/19/1/3: External parasites: aetiology of sweating sickness. 1971. P.T. Oberem
OP.3261/19/1/4: External parasites: the congenital resistance of new-born calves against heartwater. 1987. J.L. du Plessis
OP.3261/19/1/8: External parasites: a biochemical study of the tissues of *Rhipicephalus evertsi*, *Hyalomma* spp., *Exodes rubicundus*, *Boophilus* spp. and *Ornithodoros savignyei* with special reference to their toxins. 1984. J.D. Bezuidenhout
OP.3261/19/1/9: External parasites: determination of the tick load that will ensure enzootic stability with regard to heartwater. 1984. J.L. du Plessis
OP.3261/19/1/10: External parasites: the epidemiology of Karoo paralysis. 1985. J.D. Bezuidenhout
OP.3261/19/1/11: External parasites: the in vitro cultivation of *Cowdria ruminantium*. 1985. J.D. Bezuidenhout
OP.3261/19/1/12: External parasites: the role of complement, conglutinin and immune-conglutinin in the pathogenesis of heartwater. 1985. J.L. du Plessis
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VIRUSES/VIRUSSE

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Highly contagious diseases/Hoogsaansteeklike siektes

HIGHLY CONTAGIOUS VIRUSES/HOOGSAANSTEEKLIKE VIRUSSE

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POULTRY/PLUIMVEE

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BACTERIA/BAKTERIEë

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PROTOZOA/PROTOSOA

• Pathology/Patologie

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- OP.32111/19/2/1: Protozoa: quality, safety and efficacy of Onderstepoort vaccines against bovine babesiosis. 1981. D.T. de Waal
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• *Virology/Virologie*

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• Virology/Virologie

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POISONS/GIFSTOWWE

• Toxicology/Toksikologie

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AGRICULTURAL RESOURCE UTILISATION LANDBOUHULPBRONBENUTTING

RESOURCE RESEARCH/HULPBRONNAVORSING

Primary resources/Primêre hulpbronne

SOIL/GROND

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- GB.5111/32/7/3: The nature and genesis of black and red soils in the Springbok Flats and Rustenburg district. 1987. P.L.C. Grubb
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• *Remote sensing application/Afstandwaarnemingstoepassing*

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Energy/Energie

FUELS/BRANDSTOWWE

• *Engineering/Ingenieurskunde*

- LI.5121/51/1/1: Research on and development of plant oils and alcohols for engines in agriculture. 1979. J. Fuls

Surveys and demarcation/Opnames en afbakening

SOIL SURVEYS/GRONDOPNAMES

• *Soil science/Grondkunde*

- D.5131/32/1/4: Ad hoc soil surveys in the Eastern Cape Region. 1987. L.R. Hall

- D.5131/32/1/5: Soil surveys for combating of erosion and the planning of farms in the Buyskloof, Nanaga and Zuney areas of Alexandria. 1987. L.R. Hall
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- GB.5131/32/3/1: Soil surveys and investigations for irrigation purposes. 1973. F. Ellis
- GB.5131/32/3/2: Soil surveys and investigations for purposes other than irrigation. 1974. J.L. Schoeman
- N.5131/32/1/1: Farm soil surveys in Natal Region. 1980. A.D. Manson

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• *Situation analysis/Situasiebepaling*

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- K.5132/38/1/2: Veld surveys: determination of the erosion condition of the veld and lands in the north-eastern subregion of the Karoo Region. 1986. P.V. de Bruyn
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• *Remote sensing application/Afstandwaarnemingstoepassing*

- GB.5132/45/1/1: Veld surveys: mapping of natural veld types and rangeland degradation by various satellite systems. 1987. A.D. Argo
- GB.5132/45/1/2: An investigation to determine the potential of digital Landsat TM- and SPOT-data in identification of natural vegetation and changes thereof. 1988. L. Dreyer

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BOERDERYGEBIEDE

• *Ecology/Ekologie*

- K.5134/27/1/2: RHFA: final ordination of land types suitable for veld grazing into reasonably homogeneous farming areas in the Karoo Region. 1986. M. Vorster
- K.5134/27/2/1: RHFA: classification of irrigation areas in the Extension Ward Cradock. 1980. P.S. van Heerden
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- H.5134/36/1/2: The description of production possibilities of natural resources within 57 RHFAs in the Highveld Region. 1980. J.J. Scheepers
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- T.5134/36/1/3: RHFA: the analysis and classification of rainfall and evapotranspiration data of the different RHFAs of the Transvaal Region. 1990. I.J. van Rensburg
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- HK.5136/40/1/1: Other surveys: an investigation into the efficiency of study groups in Transvaal. 1984. C.H. de Waal

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- T.5141/30/1/1: Irrigation planning: the influence of row spacing and plant density on the yield of maize under trickle irrigation. 1986. W.F. van Wyk

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- *Nutrition/Voeding*

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- T.5211/30/1/1: Maize: the influence of between and within row spacing on soil water utilisation and yield under dryland conditions. 1988. I.D. Lamprecht
- T.5211/30/1/2: Summer grain: intercropping with maize (*Zea mays*) and some legumes in different row configurations at different nitrogen rates. 1989. W.F. van Wyk
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- V.5211/30/1/2: Summer grain: irrigation and nitrogen fertilisation studies with maize at Vaalharts. 1985. A. van Schalkwyk
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- H.5211/42/1/1: The development of a simulation type model to predict production of the more important summer grains in the Highveld Region. 1985. P.J. van Rooyen

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• *Physiology/Fisiologie*

- W.5212/03/1/1: Small grain: the biology of rufous brome (*Bromus diandrus*) in the Winter Rainfall Region. 1985. H.M. Ferreira

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- W.5212/05/1/1: Small grain: the influence of time and amount of application of nitrogen fertiliser on wheat production in the Winter Rainfall Region. 1980. J.W. Loubser
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- V.5212/19/1/1: Small grain: the effect of cultivars, soil/water regime and *Fusarium inoculum* levels at planting time on dryland wheat production at Glen. 1985. O. Los
- V.5212/19/2/1: Small grain: investigations on the occurrence of root disease organisms of wheat in an experimental plot under irrigation at Vaalharts. 1985. O. Los

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- H.5212/30/1/2: The influence of sowing rates on the yield of wheat on a Clovelly soil form (Blinkklip serie) in RHFA 6034 in the Highveld Region. 1988. G.G.J. Oosthuizen
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- V.5212/30/1/3: Small grain: irrigation and nitrogen fertilisation studies with wheat grown in rotation with maize at Vaalharts. 1984. A. van Schalkwyk
- V.5212/30/1/4: Small grain: determination of the water use of the short growing season wheat cultivar SST 25 under irrigation at Rietrivier. 1987. J.S. de Wet
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OIL AND PROTEIN SEEDS/OLIE- EN PROTEÏENSADE

• *Physiology/Fisiologie*

- W.5213/03/1/1: Oil and protein seeds: effect of time of application of a seaweed growth regulator on growth, development and seed yield of lupins. 1986. H.J.C. Agenbag

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- H.5213/20/1/2: Determination of feeding damage by insects to pods and seeds of groundnuts in the Highveld Region. 1987. C.F. van Eeden

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- *Crop science/Gewaskunde*

- D.5214/30/1/4: Other field crops: crop rotation for chicory in the Eastern Cape. 1980. R.S. Marr
- V.5214/30/1/1: Other field crops: cotton production under different irrigation systems at Vaalharts. 1986. A. van Schalkwyk
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- V.5214/30/1/3: Oil and protein seeds: water use of soybeans as affected by plant population and potassium fertilisation under irrigation at Riet River. 1988. C. Janse van Rensburg
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- W.5214/30/2/1: Other field crops: the evaluation of peppermint (*Mentha piperita*) for adaptation in the Winter Rainfall Region. 1985. H.H.M. van Gelder
- W.5214/30/2/2: The influence of growth stage at harvest on the yield and quality of peppermint oil. 1986. H.H.M. van Gelder

Garden crops/Tuingewasse

TUBER CROPS/KNOLGEWASSE

- *Pests/Plae*

- W.5221/20/1/1: Tuber crops: the migratory habits of aphid vectors of potato viruses in the seed potato producing areas of the winter rain cropping area. 1976. S.S. Walters

- *Crop science/Gewaskunde*

- V.5222/30/1/1: Tuber crops: potato production under different irrigation systems at Vaalharts. 1989. A. van Schalkwyk

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- *Physiology/Fisiologie*

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- N.5222/30/1/1: Vegetables: cultivar evaluation of vegetables in the mist belt of the high rainfall areas of Natal and the effects of selected fungicides on foliar disease development. 1985. W.G. Nevill
- T.5222/30/1/1: The fertilisation of vegetables in a continuous rotational cropping system. 1991. W.F. van Wyk

OTHER GARDEN CROPS/ANDER TUINGEWASSE

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- *Pests/Plae*

- W.5232/20/1/1: Distribution and movement patterns of the Cape sparrow *Passer melanurus* (Müller) - a problem bird of grapes in the irrigation areas of the Winter Rainfall Region. 1985. M.J.F. Jarvis
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RESOURCE UTILISATION RESEARCH (ANIMALS) HULPBRONBENUTTINGSNAVORSING (DIERE)

Ruminants/Herkouers

LARGE STOCK/GROOTVEE

- *Physiology/Fisiologie*

- D.5311/03/2/1: Large stock: the influence of kikuyu on the sexual maturity of Friesian heifers. 1984. J.A. Erasmus
- D.5311/03/2/2: Large stock: influence of kikuyu on the protein and energy status as well as certain endocrinological secretions in cows. 1984. W.P. Henning
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- T.5311/03/1/2: Large stock: influence of different over-wintering feeding regimes on production and growth of beef cattle. 1971. S.D. Nieman
- T.5311/03/1/3: Large stock: milk and meat production from a dual purpose breed on natural veld and dryland *Cenchrus* pastures. 1984. E.E. Lademann
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- *Reproduction/Reproduksie*

- N.5311/04/1/2: Oestrus and ovulation in mature female beef cattle as affected by changes in live mass. 1978. B.P. Louw
- N.5311/04/1/6: Large stock: the interaction between cow body condition and calving date and its effect on conception rate and intercalving interval in commercial beef herds at Dundee. 1988. J.S. Crichton
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- D.5311/05/2/3: Large stock: the influence of alkali treatment of whole maize on milk production. 1984. W.P. Henning
- D.5311/05/2/4: Large stock: serum and plasma mineral profiles of dairy heifers on kikuyu pastures. 1987. P.J. Olivier
- H.5311/05/1/2: Large stock: optimal summer utilisation of fertilised and unfertilised veld with year-old steers. 1982. A.R. Schutte
- H.5311/05/1/3: Large stock: the optimal level of phosphorus supplementation for beef cows on summer veld in the Highveld Region. 1985. A.R. Schutte
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- H.5311/05/2/2: Large stock: the utilisation of ensiled mixtures of cattle manure and maize crop residues by large stock. 1983. L.D. Snyman
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- H.5311/05/3/3: Large stock: the inclusion of different buffer levels in starter concentrates for dairy calves. 1985. C.W. Cruywagen
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- H.5311/05/3/7: Large stock: the effect of level of milk feeding and weaning age on pre- and post-weaning growth of Friesian bull calves. 1986. Joretha G. Horn
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- H.5311/05/6/1: Large stock: in vitro evaluation of the grain of different sorghum varieties for possible inclusion in concentrates of dairy cows. 1985. C.W. Cruywagen
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- H.5311/07/1/2: Large stock: the influence of genetic and environmental factors on production traits of a Simmentaler cattle herd. 1986. J.J. Viljoen
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- T.5311/41/1/2: Large stock: a stable beef cattle production system for Mopani veld. 1968. C.J.F. Lüdemann
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SMALL STOCK/KLEINVEE

● *Physiology/Fisiologie*

- D.5312/03/1/1: Small stock: reproduction parameters and levels of sex hormone secretion in Dohne Merino ewes in a spring autumn and 8-month reproduction systems. 1990. C.B. Nowers
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- T.5312/04/1/1: Small stock: effect of energy, protein and NPN on the fertility of mutton sheep ewes. 1970. G. Marincowitz
- T.5312/04/2/1: Small stock: the sexual activity of Merino woolled sheep and their crosses. 1973. L. Bouwer
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- D.5312/05/1/1: Small stock: the relationship in the seasonal variation in the beta carotene of sourveld and the beta carotene levels of blood plasma in woolled sheep. 1983. P.J.L. Zeeman
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- K.5312/05/1/2: Small stock: the effect of energy supplementation on Angora goats grazing noors (*Euphorbia coerulescens*) and Succulent mountain shrub veld. 1983. F.C. Hayward
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• *Modelling/Modellerling*

- V.5413/42/1/1: Cultivated pasture: modelling the growth of *Cenchrus ciliaris* L, cv. Molopo and the growth performance of steers grazing it in summer. 1990. L.G. du Pisani

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• *Upgrading/Veredeling*

- K.5414/07/1/3: Lucerne: the National Lucerne Evaluation Programme. 1986. E. Sykes
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• *Pests/Plae*

- V.5414/20/1/1: Lucerne: investigation on the occurrence and distribution of the white fringed beetle on lucerne in the Lower Orange River irrigation area. 1985. J. de Jager
- V.5414/20/1/2: Lucerne: evaluation of soil-applied insecticides for the control of white fringed beetle larvae on established lucerne at Upington. 1987. J. de Jager
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- W.5414/21/1/1: Lucerne: phytotoxicity and efficiency of the present and new weedicides in lucerne in the Oudtshoorn irrigation area. 1985. D.J. le Roux
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- N.5414/30/1/1: Evaluation of new lucerne cultivars for agricultural value in various bioclimatic regions at Kokstad, Cedara and Dundee. 1986. A. Smith
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- T.5414/30/1/2: Lucerne: the evaluation of new lucerne cultivars under grazing by sheep or with cutting in south-eastern Transvaal. 1988. A. Moore
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- W.5414/41/1/1: Lucerne: an evaluation of the resistance to grazing of new lucerne cultivars under dryland conditions in the Ruens area. 1985. J.D. Langenhoven
- W.5414/41/2/1: Investigation on the influence of row width, plant density and frequency of hay cuttings on seed production of three lucerne cultivars. 1987. J.D. Langenhoven
- W.5414/41/2/3: Influence of grazing method on the grazing capacity and production of four lucerne cultivars under irrigation. 1990. W. Durand

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• *Crop science/ Gewaskunde*

- H.5415/30/1/1: Annual fodder crops: the influence of time of establishment on the production of annual winter fodder crops. 1977. R.H. Drewes
- H.5415/30/1/2: Annual fodder crops: the influence of fertilisation and cutting frequency on the production of five rye grasses with limited irrigation. 1985. A.S. de Beer

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- T.5415/36/1/1: Annual fodder crops: evaluation of *Pennisetum typhoides* as a fodder crop. 1977. G.T. Rootman

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- K.5415/41/1/2: Annual fodder crops: optimum planting date of annual small grain and *Medicago* species. 1987. C.H. Donaldson

- K.5415/41/1/3: Annual fodder crops: the performance of small stock at different stocking rates on pastures under irrigation. 1988. C.H. Donaldson
- W.5415/41/1/1: Evaluation of annual fodder legume crops. 1979. J.D. Langenhoven

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• *Physiology/Fisiologie*

- W.5416/03/1/1: Drought fodder crops: influence of season, genotype and soil type on the palatability and chemical composition of *Atriplex nummularia* in the Winter Rainfall Region. 1987. S.A. Barnard

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- K.5416/41/1/3: Annual fodder crops: the performance of small stock at different stocking rates on pastures under irrigation. 1988. C.H. Donaldson

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- T.5417/30/1/1: Legume fodder crops: determination of inoculation requirements of pasture and fodder legumes. 1977. A.J. Kruger
- T.5417/30/1/2: Legume fodder crops: determination of daylength and temperature requirements for normal flowering in specific pasture and fodder legumes. 1977. A.J. Kruger
- T.5417/30/1/4: Legume fodder crops: a study of the effects of N fertilisation on the productivity of a white clover grass pasture. 1981. A.J. Kruger
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- T.5417/30/1/8: Legume fodder crops: a study of the use of maize as a cover crop for the establishment of *Coronilla varia* and *Lotus corniculatus*. 1983. D.L. Barnes
- T.5417/30/2/1: Legume fodder crops: nursery trials with pasture and fodder legumes. 1978. A.J. Kruger
- T.5417/30/2/2: Legume fodder crops: yield studies with tropical and subtropical pasture and fodder legumes at Rietondale. 1978. A.J. Kruger
- T.5417/30/2/3: Legume fodder crops: yield trials with temperate legumes. 1978. A.J. Kruger
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Veld

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- *Ecology/Ekologie*

- NW.5421/27/1/1: Game ranching decision support in respect of stocking rates and species. 1988. D.D. Berliner
- NW.5421/27/1/2: Management guidelines for the Doornpoort Experiment game farm. 1989. D.C. Smith
- NW.5421/27/1/3: A situational analysis regarding the game industry on private property in the most important game farm areas of the Transvaal and Eastern Cape Region. 1989. J.C. Pauw
- NW.5421/27/1/4: The development of TV programmes and a set of pamphlets on game ranch management. 1988. J.C. Pauw
- NW.5421/27/1/5: Reducing intertree competition through selective thinning and herbicide treatment to alleviate bush encroachment. 1990. R.J. Davies
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- NW.5421/27/2/2: Tuber dynamics of *Setaria scphacelia* var. *serecia* (staff Clayton). 1989. Y. Ford

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- *Crop science/Gewaskunde*

- NW.5431/30/1/1: Establishment practices for annual and perennial cultivar of *Cajanus cajan*. 1987. C. Sutherland
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- *Nutrition/Voeding*

- NW.5432/05/1/1: The characterisation of eight *Pennisetum* cultivars in terms of dry matter production and quality. 1989. M.J. Kleyn

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- NW.5432/07/1/1: Introduction and description of *Digitaria eriantha*. 1989. C.J. Terblanche
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• Nutrition/Voeding

- NW.5433/05/1/1: Development of a databank for quality parameters of pasture and fodder crops. 1988. M.J. Kleyen

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- NW.5433/30/1/1: The interaction between *Trifolium resupinatum* and *Lolium multiflorum* var. Westerwoldicum in mixed cultivation. 1988. M. van den Berg
- NW.5433/30/1/2: Light and carbon dioxide competition and carbon fixation of clover and rye grass in a mixed pasture. 1989. L.J. Muller
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PERENNIAL/MEERJARIG

• Pollination/Bestuiwing

- NW.5442/29/1/1: The ontogeny of *Tylosema esculentum*. 1989. H.M. de Frey
- NW.5442/29/2/1: An ecophysiological study of *Antheaphora pubescens* and *Eragrostis curvula*. 1990. J.E. Coetzee
- NW.5442/29/2/2: The influence of water stress on *Antheaphora pubescens*. 1990. A.C. Thorn

• Crop science/Gewaskunde

- NW.5442/30/1/1: Introduction of plants with potential as alternate forages. 1988. A.J. Kruger
- NW.5442/30/2/1: Initial evaluation of forage accessions in South Africa. 1988. M.J. Erasmus
- NW.5442/30/2/2: Evaluation of promising accessions in terms of climatic adaptation production, chemical composition, survival and possible application. 1988. A.J. Kruger
- NW.5442/30/3/1: Development of practical seed harvesting techniques for promising forage accessions. 1988. H. Nel
- NW.5442/30/3/2: Development of seed processing techniques for promising forage accessions. 1988. H. Nel
- NW.5442/30/3/3: Development of a seed industry and initial marketing strategy for the Grassland Research Centre. 1988. H. Nel

RESOURCE UTILISATION RESEARCH (FARMING SYSTEMS) HULPBRONBENUTTINGSNAVORSING (BOERDERYSTELSELS)

Farming enterprises/Boerderyvertakkings

STOCK AND GAME FARMING/VEE- EN WILDBOERDERY

• *Potential studies/Potensiaalstudies*

- D.5511/36/1/1: Stock and game farming: development of a viable stock farming system for the Valley bushveld in good condition in the Eastern Cape Region. 1983. J.E. Danckwerts
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- D.5511/36/1/3: Stock and game farming: development of a viable stock farming system for the dry grass-bush communities of the Eastern Cape Region. 1976. J.E. Danckwerts
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• *Management/Bestuur*

- H.5511/41/1/1: Stock and game farming: the influence of different feeding strategies on the economic and biological efficiency of beef cattle farming. 1982. R.H. Drewes
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• *Crop science/Gewaskunde*

- H.5512/30/1/1: Crop farming: the evaluation of a maize/groundnut system with plough and stubble mulch cultivation on a Zwartfontein serie in RHFA 6018 in the Highveld Region. 1988. P.J. Laubscher
- V.5512/30/1/1: Crop farming: evaluation of crop succession systems in which wheat and maize are grown under dryland conditions at Glen. 1982. C. Engelbrecht
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- V.5512/30/3/1: Crop farming: crop succession systems in which different crops are grown under irrigation at Riet River. 1988. C. Engelbrecht
- V.5512/30/3/2: Crop farming: research on the most advantageous crop rotation system under irrigation at Vaalharts. 1990. J.H. Pienaar
- V.5512/30/3/3: Crop farming: crop succession system with various crops under irrigation at Upington. 1990. J. de V. Nel

MIXED FARMING/GEMENGDE BOERDERY

• *Management/Bestuur*

- D.5513/41/1/6: The compilation of a manual to promote mixed farming production techniques in the Dohne sour grassveld. 1987. M.L. Bode
- N.5513/41/1/1: Mixed farming: the development of a farm planning manual for use in Natal Region. 1986. L.D. Papenfus
- W.5513/41/1/1: Mixed crop and animal production practices for optimum land utilisation in the Swartland. 1973. J.D. Langenhoven
- W.5513/41/1/2: A study of soil fertility in the Swartland and Rûens area using legume crops in rotation with small grain. 1978. J.D. Langenhoven
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AGRICULTURAL PRODUCTION ECONOMY RESEARCH

LANDBOUPRODUKSIE-EKONOMIENAVORSING

Macro resource economy/Makrohulpbronekonomie

PRODUCTION FACTOR STUDIES/PRODUKSIEFAKTORSTUDIES

• *Production economics/Produksie-ekonomie*

- PE.5611/48/1/1: Production factor studies: the determination of a remuneration for the management function in agricultural concerns. 1980. J.S.G. Joubert
- PE.5611/48/1/3: Production factor studies: an agricultural economic evaluation of alternative irrigation systems in the Orange-Vaal irrigation area. 1987. E.J. du Toit
- PE.5611/48/2/1: Production factor studies: the determination of the value of agriculture land in the RSA. 1976. B.D.T. Janse van Rensburg
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- PE.5611/48/2/3: Production factor studies: determination of the economic value of irrigation water in the upper Berg River and Eerste River Valley. 1982. J.M. van Zyl
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STRUCTURAL STUDIES/STRUKTUURSTUDIES

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- PE.5612/48/1/1: Structural studies: the development of an alternative methodology for the determination of minimum farm size. 1982. D. Armer
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Farm business management/Plaasbedryfsleer

BUSINESS RESULTS/BEDRYFSRESULTATE

• *Production economics/Produkisie-ekonomie*

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- PE.5621/48/1/5: Structural studies: quantification of relationships between input and output and expected economic returns of crop production with variable water supply. 1986. T. Virag
- PE.5621/48/2/2: Business results and the production cost of wheat and other branches of farming in the eastern Free State summer rain cropping areas. 1977. D.J. Mulder
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• *Production economics/Produkisie-ekonomie*

- D.5622/48/1/1: Management techniques: the development and provision of agricultural economic computer models for extension personnel in the East Coast and Albany subregions. 1987. J.F. Els
- PE.5622/48/1/1: Management techniques: the development of an elementary book keeping book for farmers. 1982. A. de K. Marais
- PE.5622/48/1/3: Management techniques: research in respect of the drawing up and computerisation of income and cost budgets (Combud). 1981. C.W. Mostert
- PE.5622/48/1/5: Management techniques: the introduction and evaluation of the financial record book for farmers. 1983. A. de K. Marais

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- PE.5622/48/1/10: Management techniques: the effect of income tax on the decision-making process of extensive livestock farmers in the Free State Region. 1986. N.F. Botha
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- PE.5622/48/8/1: Management techniques: the use of income and cost budgets for effective planning of livestock and crop enterprises in the Karoo Region. 1973. S.S. Hansen
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- PE.5622/48/9/1: Management techniques: the use of income and cost budgets for effective planning of livestock and crop enterprises in the Transvaal Region. 1973. D.C. du Toit
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- PE.5623/48/1/5: Enterprise relationship: cost benefit analysis for the supply of irrigation water out of the Theewaterskloof Dam to the Eersteriviervallei. 1986. J.M. van Zyl
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- PE.5623/48/2/5: Assessment of the profitability of irrigated pastures for livestock farming in the Highland sourveld regions of Natal. 1984. A. de K. Marais
- PE.5623/48/2/6: Some economic aspects of fertiliser usage in maize production in Natal. 1986. C.G. Berry
- PE.5623/48/2/7: Enterprise relationship: a long-term economic evaluation of sheep production systems at different stocking rates on climax grasslands in the central Free State. 1986. A. Odendaal
- PE.5623/48/2/8: Enterprise relationship: an examination of the economic and financial causes of non-optimal utilisation of natural pastures in the magisterial district of Gordonia. 1988. J.J. Kamfer
- PE.5623/48/3/1: Enterprise relationship: the economic evaluation of the utilisation of fodder crops with Merino sheep in the Fish River Valley. 1982. S.S. Hansen
- PE.5623/48/3/2: Enterprise relationship: the economic evaluation of development studies of components of dry-grass bushveld grazing in the Eastern Cape. 1976. C.J. Potgieter
- PE.5623/48/3/3: Enterprise relationship: the economic evaluation of the potential pastures in respect of small stock in the eastern coastal areas of the Eastern Cape. 1976. C.J. Potgieter
- PE.5623/48/3/4: Enterprise relationship: the development and evaluation of a profitable livestock farming system for the Valley bushveld areas in good condition in the Eastern Cape Region. 1983. C.J. Potgieter
- PE.5623/48/3/5: Enterprise relationship: the development and evaluation of a profitable livestock farming system for the Valley bushveld in deteriorated condition of the Eastern Cape Region. 1983. C.J. Potgieter
- PE.5623/48/3/6: Enterprise relationship: the development, management and evaluation of adapted livestock farming system Campagna in the high rainfall sourveld areas of the Eastern Cape. 1983. C.J. Potgieter
- PE.5623/48/4/1: Enterprise relationship: wintering of woolled sheep and other livestock in the northern Drakensberg grazing region. 1982. H.A. Minnaar
- PE.5623/48/4/3: Enterprise relationship: the influence of different feeding strategies on the economic efficiency of beef cattle in the summer rain cropping areas. 1983. J.J. de Bruyn
- PE.5623/48/4/5: An economic analysis of dairy enterprises and their financial roles in the farming structure of mixed farming in the summer rain cropping area. 1984. P.J. Cornelius
- PE.5623/48/4/7: Enterprise relationship: strategy for production continuation and renewal of citrus and subtropical orchards in the bushveld area. 1984. D.C. du Toit
- PE.5623/48/4/9: Enterprise relationship: the economic evaluation of the RHFA concept with respect to the minimising of risk and the determination of land values. 1986. J.J. de Bruyn
- PE.5623/48/4/10: Enterprise relationship: the influence of different feeding strategies on the economic efficiency of small stock farming in the summer rain cropping areas. 1986. P.F. du Plessis
- PE.5623/48/4/11: The economic justification of the introduction/expansion of livestock enterprises in stead of crop production on marginal soils. 1988. F.J. de Jager

Soil conservation/Grondbewing

EROSION/EROSIE

• *Situation analysis/Situasiebepaling*

- V.5711/35/1/1: Erosion: investigation of the functional efficiency of subsidised waterways in the middle Free State subregion. 1985. S.J. van Reenen

• *Conservation studies/Bewaringstudies*

- D.5711/38/1/1: Erosion: the determination of soil losses associated with various tillage practices on various soil series established to pineapples in the East London district. 1982. B. Denyer
- D.5711/38/1/2: Erosion: the determination of soil losses associated with various tillage practices and land use on soil series at Alexandria. 1983. B. Denyer
- D.5711/38/1/3: The determination of soil losses associated with various tillage practices and land use on various soil series in Humansdorp Extension Ward. 1986. B. Denyer
- D.5711/38/1/4: Erosion: the correlation of soil loss figures obtained from natural run-off plots and rainfall simulator trials on pineapple ridges. 1985. B. Denyer
- D.5711/38/2/2: Erosion: the effect of various small structures in eroded watercourses in the High rainfall sourveld. 1985. E. Marx
- D.5711/38/2/3: Erosion: the effect of small structures in eroded watercourses in the bushveld areas. 1984. G.M. Bicknell
- D.5711/38/2/4: The influence of small conservation structures and re-established plant cover in the eroded low lying areas in the Henderson semi-palatable bushveld. 1987. P.C. Griffiths
- D.5711/38/4/1: To determine the maximum safe length and fall in ridges as well as spacing of contours on various pineapple land lay-outs associated with various tillage practices and soil series in order to combat erosion. 1985. B. Denyer
- D.5711/38/5/1: Erosion: the effect of burning and post-burn grazing practices on run-off and soil loss in the Dohne sour grassveld. 1988. M.L. Bode
- N.5711/38/1/1: Erosion studies using natural run-off plots. 1985. W.B. Russell
- N.5711/38/1/2: Studies using a rainfall simulator and natural run-off plots to quantify soil losses from veld. 1982. R.P. Simms
- N.5711/38/1/3: Erosion and run-off studies on pineapple lands in Zululand. 1987. W.B. Russell
- N.5711/38/1/4: Study of the rainfall erosivity pattern of the Natal Region. 1988. M.D. Gibbs
- V.5711/38/1/1: Erosion: investigation of adapted grass covers for waterways in RHFA 4053. 1985. P.J. Knoester
- V.5711/38/2/1: Erosion: water run-off control planning of the Immigrant area in the Petrusburg Extension Ward. 1985. F.J. Smit
- V.5711/38/2/2: Erosion: water run-off control planning of subcatchment area 3 of the Korannaberg catchment area in the Excelsior district in the Brandfort Extension Ward. 1985. S.J. van Reenen
- V.5711/38/2/3: Erosion: water run-off control planning of the Rondas area in the Brandfort Extension Ward. 1986. C.S. van Niekerk
- V.5711/38/2/4: Erosion: water run-off control planning of the Spioenheuvel area in the Boshof district in the Kimberley Extension Ward. 1987. J.H. Mulder
- V.5711/38/3/1: Erosion: investigation of the functional efficiency of different types of small conservation structures in eroded areas in dongas and gullies in the Edenburg Extension Ward. 1985. S. Brink

- V.5711/38/3/2: Erosion: investigation of the functional efficiency of different types of small conservation structures in dongas and gullies in the Postmasburg Extension Ward. 1985. J. Weyers

• *Engineering/Ingenieurskunde*

- LI.5711/51/1/1: Engineering aspects of soil erosion: aspects of gully erosion. 1983. P.J. Strumpher
LI.5711/51/1/2: Engineering aspects of soil erosion: aspects regarding soil losses. 1983. P. McPhee

DRAINAGE/DREINERING

• *Agrohydrology/Agrohidrologie*

- V.5712/34/1/1: The planning and implementation of drainage systems on waterlogged and salinised irrigation lands in the Vaalharts irrigation area. 1985. J.H. Mulder
V.5712/34/1/2: The planning and implementation of drainage systems on waterlogged and salinised irrigation lands in the Douglas Extension Ward. 1985. J.H. Mulder

RESOURCE CONSERVATION/HULPBRONBEWARING

Planning of areas/Beplanning van gebiede

FARM PLANNING/PLAASBEPLANNING

• *Agrohydrology/Agrohidrologie*

- N.5831/34/1/1: Farm planning: run-off control planning in the Howick Extension Ward. 1979. M.G. Price
N.5831/34/1/2: Farm planning: run-off control planning in the Greytown Extension Ward. 1979. R.C. Richardson
N.5831/34/1/3: Farm planning: run-off control planning in the Ixopo Extension Ward. 1979. A.D. Simpson
N.5831/34/1/4: Farm planning: run-off control planning in the Pongola Extension Ward. 1979. R.J. Dicks
N.5831/34/1/5: Farm planning: run-off control planning in the Kokstad Extension Ward. 1979. D.B. Austin
N.5831/34/1/6: Farm planning: run-off control planning in the Richmond Extension Ward. 1979. E.M.F. McAllister
N.5831/34/1/7: Farm planning: run-off control planning in the Newcastle Extension Ward. 1979. M.P. Wentzel
N.5831/34/1/8: Farm planning: run-off control planning in the Vryheid Extension Ward. 1979. R.J. Dicks
N.5831/34/1/9: Farm planning: run-off control planning in the Estcourt Extension Ward. 1979. S.K. Armour
N.5831/34/1/10: Farm planning: run-off control planning in the Dundee Extension Ward. 1979. P.P. Kloppers
N.5831/34/1/11: Farm planning: run-off control planning in the Pietermaritzburg Extension Ward. 1979. P.J.D. Nicholson
N.5831/34/1/12: Farm planning: run-off control planning in the Ladysmith Extension Ward. 1979. K.W. Watkinson
T.5831/34/1/2: Farm planning: run-off control of the north-eastern Springbok Flats area. 1980. J. Bellingham

- T.5831/34/1/3: Farm planning: run-off control in the south-eastern area of the Transvaal Region. 1976. M.M. Struthers
- T.5831/34/1/4: Farm planning: run-off control in the middle Transvaal area of the Transvaal Region. 1979. K.P. de Beer
- T.5831/34/1/5: Farm planning: run-off control in the Annysspruit area of the south-eastern Transvaal area. 1975. J.C. Nel
- T.5831/34/1/6: Farm planning: run-off control in the Klein-Komati area of the south-eastern Transvaal. 1975. J.C. Mouton
- T.5831/34/1/11: Farm planning: the design of a water run-off control system for the Strydom block area - Lowveld, Komatipoort. 1975. M.V. Watrus
- T.5831/34/1/12: Farm planning: run-off control in the Sabie Valley area - the design of a water run-off control system in the Sabie Valley and White River. 1975. M.V. Watrus
- T.5831/34/1/13: Farm planning: run-off control in the western Transvaal area (Syferbult) of the Transvaal Region. 1985. J.T. Nel
- T.5831/34/2/1: Farm planning: run-off control in the Badplaaskom area of the south-eastern area of the Transvaal Region. 1975. H.P. den Dulk
- T.5831/34/2/2: Farm planning: run-off control in the western Transvaal (Bokfontein) area of the Transvaal Region. 1986. C.J. Meiring
- T.5831/34/2/3: Run-off control in the western Transvaal area (Koedoeshoop West) of the Transvaal Region. 1986. G.P. Engelbrecht

● *Conservation studies/Bewaringstudies*

- T.5831/38/1/1: The physical and hydrographical planning of farms in the Warmbaths ward. 1989. M.F. Joubert
- T.5831/38/1/2: The physical and hydrographical planning of farms in the Nylstroom ward. 1989. B.F. Greeff
- T.5831/38/1/3: The physical and hydrographical planning of farms in the Potgietersrus ward. 1991. E.A. van der Merwe
- T.5831/38/1/4: The physical and hydrographical planning of farms in the Pietersburg ward. 1989. D.W. Nell
- T.5831/38/1/6: Farm planning: the survey, design, specification and inspection of erosion facilities in the Warmbaths ward. 1989. M.F. Joubert
- T.5831/38/1/7: Farm planning: the survey, design, specification and inspection of erosion facilities in the Nylstroom ward. 1989. B.F. Greeff
- T.5831/38/1/8: Farm planning: the survey specification, completion and inspection of erosion facilities in the Potgietersrus ward. 1991. E.A. van der Merwe
- T.5831/38/1/9: Farm planning: the survey, design, specification and inspection of erosion facilities in the Pietersburg ward. 1989. D.W. Nell
- T.5831/38/2/1: The physical and hydrographical planning of farms in the Thabazimbi ward. 1990. C.J.H. Möller
- T.5831/38/2/2: Farm planning: the physical and hydrographical planning of farms in the Ellisras ward. 1989. J.J. Pretorius
- T.5831/38/2/3: The physical and hydrographical planning of farms in the Messina ward. 1989. J.P. Janse van Rensburg
- T.5831/38/2/4: Farm planning: the survey, design, specification and inspection of erosion facilities in the Thabazimbi ward. 1990. C.J.H. Möller
- T.5831/38/2/5: Farm planning: the survey, design, specification and inspection of erosion facilities in the Ellisras ward. 1989. J.J. Pretorius
- T.5831/38/2/6: Farm planning: the survey, design, specification and inspection of erosion facilities in the Messina ward. 1989. J.P. Janse van Rensburg

- T.5831/38/2/7: Farm planning: the survey, specification, installation and inspection of a test drainage pipe at Weipe in the Messina ward. 1989. J.P. Janse van Rensburg
- T.5831/38/3/1: Farm planning: the physical planning of farms and the specification of soil conservation structures in the Nelspruit North ward. 1989. P.J. Venter
- T.5831/38/3/2: Farm planning: the survey, specification and inspection of erosion structures in the Nelspruit North ward. 1989. P.J. Venter
- T.5831/38/3/3: Farm planning: the physical planning of farms and the specification of soil conservation structures in the Nelspruit South ward. 1989. P.J.L. Bierman
- T.5831/38/3/4: Farm planning: the survey, specification and inspection of soil conservation structures in the Nelspruit South ward. 1990. P.J.L. Bierman
- T.5831/38/3/5: Farm planning: the physical planning of farms and the specification of soil conservation structures in the Tzaneen ward. 1989. J.H. van Eyk
- T.5831/38/3/6: Farm planning: the survey, specification and inspection of erosion structures in the Tzaneen ward. 1989. J.H. van Eyk
- T.5831/38/3/7: Farm planning: the physical planning of farms and the specification of soil conservation in the Lydenburg ward. 1989. L.C.R. Hartzer
- T.5831/38/3/8: Farm planning: the survey, specification and inspection of erosion structures in the Lydenburg ward. 1989. L.C.R. Hartzer
- T.5831/38/4/1: Farm planning: the physical and hydrographical planning of farms in the Belfast ward. 1989. G.P. Engelbrecht
- T.5831/38/4/2: Farm planning: the physical and hydrographical planning of farms in the Carolina ward. 1989. H.S. du Toit
- T.5831/38/4/3: Farm planning: the physical and hydrographical planning of farms in the Ermelo ward. 1989. P.J. Gerber
- T.5831/38/4/4: Farm planning: the physical and hydrographical planning of farms in the Piet Retief ward. 1989. J.C. Nel
- T.5831/38/4/5: Farm planning: the physical and hydrographical planning of farms in the Volksrust ward. 1989. O.G. Wartington
- T.5831/38/4/6: Farm planning: the survey, design, specification and inspection of conservation works in the Belfast ward. 1989. G.P. Engelbrecht
- T.5831/38/4/7: Farm planning: the survey, design and inspection of conservation works in the Carolina ward. 1989. M.S. du Toit
- T.5831/38/4/8: Farm planning: the survey, design, specification and inspection of conservation works in the Ermelo ward. 1989. P.J. Gerber
- T.5831/38/4/9: Farm planning: the survey, design, specification and inspection of conservation works in the Piet Retief ward. 1989. J.C. Nel
- T.5831/38/4/10: Farm planning: the survey, design, specification and inspection of conservation works in the Volksrust ward. 1989. O.G. Wartington
- T.5831/38/5/1: Farm planning: the physical and hydrographical planning of farms in the Groblersdal ward. 1990. L.M. van Rooyen
- T.5831/38/5/2: Farm planning: the survey, design, specification and inspection of conservation works in the Groblersdal ward. 1990. L.M. van Rooyen
- T.5831/38/5/3: Farm planning: the physical and hydrographical planning of farms in the Bronkhorstspuit ward. 1989. G.P.J. Erasmus
- T.5831/38/5/4: Farm planning: the survey, design, specification and inspection of conservation works in the Bronkhorstspuit ward. 1989. G.P.J. Erasmus
- T.5831/38/5/5: Farm planning: the physical and hydrographical planning of farms in the Silverton ward. 1990. M.M. Struthers
- T.5831/38/5/6: Farm planning, the survey, design, specification and inspection of conservation works in the Silverton ward. 1990. M.M. Struthers

- T.5831/38/5/7: Farm planning: the physical and hydrographical planning of farms in the Middelburg ward. 1989. K.P. de Beer
- T.5831/38/5/8: Farm planning: the survey, design, specification and inspection of conservation works in the Middelburg ward. 1989. K.P. de Beer
- T.5831/38/5/9: Farm planning: the revision of documentation for the execution of the financial aid scheme in the Middle Transvaal subregion 1990. A.C.T. Hitchcock
- T.5831/38/6/1: Farm planning: the physical and hydrographical planning of farms in the Rustenburg ward. 1989. J.T. Nel
- T.5831/38/6/2: Farm planning: the survey, design, specification and inspection of conservation works in the Rustenburg ward. 1989. J.T. Nel
- T.5831/38/6/3: Farm planning, the physical and hydrographical planning of farms in the Brits ward. 1989. J.J. Jacobs
- T.5831/38/6/4: Farm planning: the survey, design, specification and inspection of conservation works in the Brits ward. 1989. J.J. Jacobs
- T.5831/38/6/5: Farm planning: the physical and hydrographical planning of farms in the Zeerust ward. 1989. C.J. Meiring
- T.5831/38/6/6: Farm planning: the survey, design, specification and inspection of conservation works in the Zeerust ward. 1989. C.J. Meiring

• *Management/ Bestuur*

- D.5831/41/1/1: Planning of farms within the Alexandria magisterial district to promote the efficient conservation of natural resources. 1984. A.E.O. Botha
- D.5831/41/1/2: Planning of farms with regard to veld utilisation and resource conservation within the Elliot Extension Ward to promote the efficient utilisation and conservation of natural resources. 1985. E. Marx
- D.5831/41/1/3: Farm planning within the Barkly East Extension Ward to promote efficient utilisation and conservation of natural resources. 1985. J.S.J. Jordaan
- D.5831/41/1/4: Farm planning of farms within the Adelaide Extension Ward to promote efficient utilisation and conservation of natural resources. 1985. G.M. Bicknell
- D.5831/41/1/5: Planning of farms within the Bathurst magisterial district to promote the efficient utilisation and conservation of natural resources. 1985. B.I. Hill
- D.5831/41/1/6: Planning of farms within the Tarkastad magisterial district to promote the efficient utilisation and conservation of agricultural resources. 1983. W.J.M. Els
- D.5831/41/1/7: Planning of farms in the Komga magisterial district to promote the efficient utilisation and conservation of the natural resources. 1984. C.J. Bradfield
- D.5831/41/1/8: Planning of farms in the Stutterheim Extension Ward to promote the efficient utilisation and conservation of the natural resources. 1984. P.C. Griffiths
- D.5831/41/1/9: Planning of farms within the Sterkstroom magisterial district to promote the efficient utilisation and conservation of the natural resources. 1983. J.H. Fourie
- D.5831/41/1/10: Planning of farms within the Albany magisterial district to promote efficient utilisation and conservation of natural resources. 1986. W.J. Penny
- D.5831/41/1/11: Planning of farms with regard to veld utilisation and resource conservation within the Humansdorp Extension Ward to promote the efficient utilisation and conservation of natural resources. 1985. J.P. van Zyl
- D.5831/41/1/12: Planning of farms within the Molteno magisterial district (Dordrecht Extension Ward) to promote efficient utilisation and conservation of the natural resources. 1985. J.C. van der Walt
- D.5831/41/1/13: Planning of farms within the Uitenhage and Kirkwood magisterial districts to promote the efficient utilisation and conservation of the natural resources. 1985. C.S. van R. Müller

- D.5831/41/1/14: Planning of farms within the Queenstown magisterial district to promote the efficient utilisation and conservation of the natural resources. 1983. W.J.M. Els
- D.5831/41/1/15: Planning of farms in the Port Elizabeth magisterial district of the eastern seaboard area. 1986. R.P. Laing
- D.5831/41/1/16: Planning of farms within the Aliwal North Extension Ward to promote efficient utilisation and conservation of the natural resources. 1985. D.T. Bezuidenhout
- D.5831/41/2/1: Run-off control planning of farms in the sub-catchment area No. 10900104 in the Humansdorp Extension Ward. 1984. J.P. van Zyl
- D.5831/41/2/2: Run-off control planning of farms in the Zuney Valley, sub-catchment area No. 14200200. 1984. A.E.O. Botha
- D.5831/41/2/3: Farm planning: area run-off control planning in catchment areas No. 041308, 041309 and 041312 within the Barkly East Extension Ward. 1985. J.S.J. Jordaan
- D.5831/41/2/4: Farm planning: area run-off control planning in sub-catchment No. 17500400 in the Elliot Extension Ward. 1985. E. Marx
- D.5831/41/2/5: Run-off control planning of farms in the Baviaans River catchment area - drainage region No. 1560 - Bedford magisterial district. 1985. G.M. Bicknell
- D.5831/41/2/6: Area run-off control planning of farms in the Elands River Valley sub-catchments No 12100100 and 11700300. 1985. C.S. van R. Müller
- D.5831/41/2/7: Farm planning: stabilising of eroded watercourses in upper Heuningklip River - sub-catchment area 1730/02/04. 1983. J.E. Aspinall
- D.5831/41/2/8: Farm planning: run-off control planning in a portion of the sub-catchment area No. 04130500 (Bossielaagte) situated in the Lady Grey magisterial district. 1985. D.T. Bezuidenhout
- D.5831/41/2/9: Water run-off control planning of farms in the area demarcated as Upper-Coerney, sub-catchment No. 13401501 in the Paterson area. 1985. R.P. Laing
- D.5831/41/2/11: Area run-off control planning of farms in the Buyskloof Valley, sub-catchment No. 14200100, in the eastern seaboard area. 1986. A.E.O. Botha
- D.5831/41/2/12: Farm planning: maintenance and improvement of existing run-off control plans on cultivated lands in the catchment areas No. 041308, 041309 and 041312 within the Barkly East Extension Ward. 1985. J.S.J. Jordaan
- D.5831/41/2/13: Farm planning: run-off control planning in the sub-catchment area 15430101 (Vrolikskraal) situated in the Molteno magisterial district. 1985. J.C. van der Walt
- D.5831/41/2/14: Farm planning: water run-off control - improvement and maintenance of existing contour systems in the Elands River catchment area. 1986. I. du P. Barlow
- D.5831/41/2/15: Farm planning: stabilising of eroded watercourses in Bamboeshoek, sub-catchment area No. 17300201. 1984. J.H. Fourie
- D.5831/41/2/16: Area run-off control planning of farms in the sourveld area in the Humansdorp Extension Ward of the Karoo and arid areas. 1986. E.C. Kieck
- D.5831/41/2/17: Area run-off control planning of farms in the Upper Krom River area in the Humansdorp Extension Ward of the eastern seaboard area. 1986. E.C. Kieck
- D.5831/41/2/18: Farm planning: area run-off control planning of irrigation lands in the Hankey magisterial district. 1986. R.P. Laing
- D.5831/41/2/19: Water run-off control planning of all pineapple farms in the East London Extension Ward. 1985. I.D. Scholtz
- D.5831/41/2/20: Farm planning: area run-off control planning of irrigation in the proposed Kabeljou irrigation area in the Humansdorp magisterial district. 1987. E.C. Kieck
- D.5831/41/2/21: Farm planning: area run-off control planning of lands in the Blue River Valley. 1988. C.J. Bradfield
- D.5831/41/2/22: Farm planning: water run-off control - determining the most suitable grass(es) to be used in waterways and watercourses in the Algoa subregion. 1988. I. du P. Barlow

ENTREPRENEUR DEVELOPMENT ONDERNEMERSONTWIKKELING

EXTENSION SCIENCE INVESTIGATIONS VOORLIGTINGKUNDIGE ONDERSOEKE

Resources and technology/Hulpbronne en tegnologie

MANAGEMENT FACTORS/BESTUURSAKTORE

• *Persuasion/Oorreding*

- T.6114/39/1/2: To create an awareness among farmers of the breeding and feeding problems by means of performance test competitions in the Volksrust Extension Ward. 1989. H.P.J. Scholtz
- T.6114/39/1/3: Creating an awareness of specific fodder-flow problems (in winter and summer) by means of case studies at individual farmers of the Volksrust Extension Ward. 1989. H.P.J. Scholtz
- T.6114/39/1/4: The use of performance testing by individual farmers in the Volksrust Extension Ward as an aid to solve their problems. 1989. H.P.J. Scholtz
- T.6114/39/1/6: Fodder flow planning for individual farmers in the Volksrust Extension Ward. 1989. H.P.J. Scholtz

• *Management/Bestuur*

- H.6114/41/1/1: Management factors: an investigation of the applicability of strategic management by agriculture procedures and the development of management strategies for this purpose. 1991. P.U. for C.H.E.
- H.6114/41/1/2: Management factors: a strategic approach to agricultural development by agricultural co-operations with special reference to Noordwes Koöperasie. 1991. P.U. for C.H.E.

MAN/MENS

• *Extension science/Voorligtingkunde*

- N.6115/40/1/1: Human potential in relation to optimum land use of farmers in the Underberg Extension Ward. 1974. D.M. Rix

RUN-OFF CONTROL/AFLOOPBEHEER

• *Agrohydrology/Agrohidrologie*

- T.6118/34/1/6: Run-off control in the Klein Komati area of the south-eastern Transvaal. 1975. J.C. Mouton
- T.6118/34/1/10: Run-off control: the design of a water run-off control system in the Bokpoort target area in Potgietersrus. 1975. J. Bellingham
- T.6118/34/1/11: Run-off control: the design of a water run-off control system for the Strydom block area - Lowveld, Komatipoort. 1975. M.V. Watrus
- T.6118/34/1/12: Run-off control in the Sabie Valley area - the design of a water run-off control system in the Sabie Valley, Witrivier. 1975. M.V. Watrus
- T.6118/34/2/1: Run-off control in the Badplaaskom area of the south-eastern Transvaal area of the Transvaal Region. 1975. J.C. Mouton

• *Extension science/Voorligtingkunde*

- N.6119/40/1/1: The use of agricultural literature in communicating information to farmers in the Natal Region. 1982. Marion A. Abbott
- W.6119/40/1/1: Communication: an extension science investigation into the effectiveness of the table grape block competition in the Hex River Valley. 1985. G.G. van der Merwe

PROGRAMMED EXTENSION/GEPROGRAMMEERDE VOORLIGTING

Resource utilisation/Hulpbronbenutting

STOCK AND GAME FARMING/VEE- EN WILDBOERDERY

• *Situation analysis/Situasiebepaling*

- D.6211/35/2/1: Stock and game farming: potential studies in the "Duneveld" farming area of the Riversdale Extension Ward. 1988. J.W. du Preez
- W.6211/35/1/1: Stock and game farming: situation study of dairy farming in the Swartland, Boland, Klein-Karoo and South Coast subregions. 1988. J.A.J. Baard

• *Evaluation/Evaluasie*

- D.6211/37/1/1: Stock and game farming: to demonstrate the utilisation and control of tree and shrub species in the humid grass/bush communities of the Bathurst Extension Ward. 1987. P.G. King
- D.6211/37/1/2: Stock and game farming: to assess vegetation change in the Alexandria ward due to the aerial application of a herbicide to *Acacia karroo*. 1986. A.E. du Plessis

• *Persuasion/Oorreding*

- D.6211/39/1/1: Stock and game farming: the persuasion of farmers to promote optimal pasture utilisation and animal production in the Queenstown Extension Ward. 1984. L.P.J. Swart
- D.6211/39/1/2: Stock and game farming: the persuasion of farmers to promote optimal pasture utilisation and animal production in the Bedford magisterial district. 1986. J.B. Marais
- D.6211/39/1/3: Stock and game farming: the persuasion of farmers to promote optimal pasture utilisation and animal production in the Albany magisterial district. 1986. J.L. Clacey
- D.6211/39/1/5: Stock and game farming: the persuasion of farmers to promote optimal pasture utilisation and animal production in the Alexandria Extension Ward. 1986. A.E. du Plessis
- D.6211/39/1/6: Stock and game farming: training of collaborators and extension officers in the Eastern Cape Region to achieve optimum milk production. 1986. P.J. Olivier
- D.6211/39/1/7: Stock and game farming: promotion of adopted stock farming in the Valley Bushveld of the Uitenhage Extension Ward. 1984. L.O. Grobler
- D.6211/39/1/8: Stock and game farming: persuasion of farmers in the Port Elizabeth Extension Ward to achieve optimum pasture and animal production. 1987. J.B.C. Kilfoil
- D.6211/39/1/9: Stock and game farming: training of farmer collaborators and extension staff in the Eastern Cape Region to promote optimum small stock production. 1987. J.C. Scheltema

- D.6211/39/1/10: Stock and game farming: the persuasion of farmers in the Thomas River conservation district to control and eradicate silver and black wattle. 1986. A.M. Grenfell
- D.6211/39/1/11: Stock and game farming: the persuasion of farmers to promote optimal pasture utilisation and animal production in the Stutterheim Extension Ward. 1986. A.M. Grenfell
- D.6211/39/1/12: Stock and game farming: the determination of veld grazing utilisation practices and farmer's knowledge and perceptions regarding these veld management practices in the King William's Town and Komga districts. 1985. W.E. Ristow
- D.6211/39/1/13: Stock and game farming: the persuasion of farmers to promote optimal pasture utilisation and animal production in the King William's Town and Komga districts. 1986. W.E. Ristow
- D.6211/39/1/14: Stock and game farming: the persuasion of farmers to promote optimal pasture utilisation and animal production in the Humansdorp Extension Ward - high potential agricultural area. 1987. F.J. Weitz
- D.6211/39/1/15: Stock and game farming: the persuasion of farmers to promote optimal pasture utilisation and animal production in the Humansdorp Extension Ward - sourveld. 1987. F.J. Weitz
- D.6211/39/1/16: Stock and game farming: the persuasion of farmers to achieve optimum grazing utilisation and animal production in the Dordrecht Extension Ward. 1986. D.W. Schoeman
- D.6211/39/1/17: Stock and game farming: the persuasion of farmers to promote optimal veld utilisation and animal production in the Elliot Extension Ward. 1987. G.R. Morgan
- D.6211/39/1/18: Stock and game farming: the persuasion of farmers to promote optimal maize production in the Elliot Extension Ward. 1987. G.R. Morgan
- D.6211/39/1/19: Stock and game farming: the persuasion of farmers to achieve optimal pasture utilisation and animal production in the Elliot Extension Ward. 1987. G.R. Morgan
- D.6211/39/1/20: Stock and game farming: the persuasion of farmers to achieve optimum pasture utilisation and animal production in the Aliwal North Extension Ward. 1986. O.V. Loest
- D.6211/39/1/21: Stock and game farming: the persuasion of farmers to promote optimal pasture utilisation and animal production in the Elands River area at the Uitenhage Extension Ward. 1988. L.O. Grobler
- D.6211/39/2/1: Stock and game farming: promotion of adapted stock farming in the Valley bushveld of the Uitenhage Extension Ward. 1984. L.O. Grobler
- K.6211/39/1/1: Stock and game farming: persuasion of farmers to apply the group camp approach of veld management in the Extension Ward of Graaff-Reinet. 1985. J.G. Theron
- K.6211/39/1/2: Stock and game farming: persuasion of farmers to apply the group camp approach of veld management in the Cradock Extension Ward. 1985. P.S. van Heerden
- K.6211/39/1/3: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Burgersdorp Extension Ward. 1985. J.H. Spoelstra
- K.6211/39/1/4: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Colesberg Extension Ward. 1985. M. van Niekerk
- K.6211/39/1/5: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the De Aar Extension Ward. 1985. N. Wilson
- K.6211/39/1/6: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Middelburg Extension Ward. 1985. J.D. Blom
- K.6211/39/1/7: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Calvinia Extension Ward. 1985. N. Nortje
- K.6211/39/1/8: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Carnarvon Extension Ward. 1985. G.Z.J. Barnard
- K.6211/39/1/9: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Kenhardt Extension Ward. 1985. J.J. Zandberg

- K.6211/39/1/10: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Prieska Extension Ward. 1985. D.J. Roux
- K.6211/39/1/11: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Beaufort West Extension Ward. 1986. A.J. Wiid
- K.6211/39/1/12: Stock and game farming: persuasion of farmers to practise the group camp approach of veld management in the Fraserburg Extension Ward. 1986. I.J. van der Merwe
- K.6211/39/2/1: Stock and game farming: persuasion of farmers to introduce drought fodder crops in the farming systems in the Graaff-Reinet Extension Ward. 1984. J.G. Theron
- K.6211/39/2/2: Stock and game farming: persuasion of farmers to establish drought fodder crops in the Colesberg Extension Ward. 1985. M. van Niekerk
- K.6211/39/2/3: Stock and game farming: persuasion of farmers to establish drought fodder crops in the De Aar Extension Ward. 1985. W.H. van Staden
- K.6211/39/2/4: Stock and game farming: persuasion of farmers to establish drought fodder crops in the Middelburg Extension Ward. 1985. J.D. Blom
- K.6211/39/2/5: Stock and game farming: persuasion of farmers to introduce drought fodder crops in the farming systems in the Calvinia Extension Ward. 1985. N. Nortje
- K.6211/39/2/6: Stock and game farming: persuasion of farmers to introduce drought fodder crops in the farming systems in the Carnarvon Extension Ward. 1985. G.Z.J. Barnard
- K.6211/39/2/7: Stock and game farming: persuasion of farmers to introduce drought fodder crops in the farming systems in the Kenhardt Extension Ward. 1985. J.J. Zandberg
- K.6211/39/2/8: Stock and game farming: persuasion of farmers to introduce drought fodder crops in the farming systems in the Prieska Extension Ward. 1985. D.J. Roux
- K.6211/39/2/9: Stock and game farming: persuasion of farmers to plant drought fodder crops in the Beaufort West Extension Ward. 1986. A.J. Wiid
- K.6211/39/3/1: Stock and game farming: promotion of the combating of proclaimed weeds in the veld in the Somerset East Extension Ward. 1985. J.C. van Aardt
- K.6211/39/3/2: Stock and game farming: promotion of the combating of proclaimed weeds in the Graaff-Reinet Extension Ward. 1980. J.G. Theron
- K.6211/39/3/4: Stock and game farming: persuasion of putative trespassers of the Agricultural Resources Act in the Jansenville Extension Ward. 1987. E.M. Bosch
- K.6211/39/3/5: Stock and game farming: persuasion of putative trespassers of the Agricultural Resources Act in the Somerset East Extension Ward. 1987. J.C. van Aardt
- K.6211/39/4/1: Stock and game farming: persuasion of putative trespassers of the Agricultural Resources Act in the Cradock Extension Ward. 1985. P.S. van Heerden
- K.6211/39/4/2: Stock and game farming: persuasion of putative trespassers of the Agricultural Resources Act in the Graaff-Reinet Extension Ward. 1985. J.G. Theron
- K.6211/39/4/3: Stock and game farming: persuasion of putative trespassers of the Agricultural Resources Act in the Middelburg (C.P.) Extension Ward. 1985. J.D. Blom
- N.6211/39/1/3: Stock and game farming: the promotion of cultivated pastures in the Ixopo Extension Ward. 1985. M.J. Pereira da Conceico
- N.6211/39/2/1: Stock and game farming: the promotion of improved veld management practices in the Weenen conservation district. 1974. S.K. Armour
- N.6211/39/2/2: Stock and game farming: the promotion of improved veld management practices in the Muden area of the Umvoti magisterial district. 1979. K.G. Camp
- N.6211/39/5/1: Stock and game farming: the promotion of grazing and animal management practices in the Underberg conservation area. 1986. C.M. Allan
- V.6211/39/1/1: Stock and game farming: the persuasion of stock farmers in the Molopo Extension Ward to contain bush encroachment. 1985. M.J. van den Heever
- V.6211/39/1/2: Stock and game farming: the persuasion of stock farmers in the Molopo Extension Ward to adopt improved grazing and stock farming practices. 1985. M.J. van den Heever

- V.6211/39/1/3: Stock and game farming: the persuasion of stock farmers in the Molopo Extension Ward to keep farming records and to adopt financial management practices. 1985. M.J. van den Heever
- V.6211/39/1/4: Stock and game farming: the persuasion of demonstrator farmers to determine the grazing potential of grazing capacity zones in the Molopo Extension Ward. 1985. M.J. van den Heever
- V.6211/39/2/1: Stock and game farming: the persuasion of stock farmers in the Postmasburg Extension Ward to contain bush encroachment. 1985. L.J. de Jager
- V.6211/39/2/2: Stock and game farming: the determination of veld and stock management practices in the Postmasburg Extension Ward. 1985. L.J. de Jager
- V.6211/39/2/3: Stock and game farming: the persuasion of stock farmers in the Postmasburg Extension Ward to keep farming records and to adopt financial management practices. 1985. L.J. de Jager
- V.6211/39/2/4: Stock and game farming: the persuasion of demonstrator farmers to determine the grazing potential of grazing capacity zones in the Postmasburg Extension Ward. 1985. L.J. de Jager
- V.6211/39/4/1: Stock and game farming: the persuasion of stock farmers in the Brandfort Extension Ward to change their attitude towards veld management. 1985. H. Putter
- V.6211/39/4/2: Stock and game farming: the persuasion of stock farmers in the Brandfort Extension Ward to adopt radical veld improvement practices. 1985. H. Putter
- V.6211/39/4/3: Stock and game farming: the persuasion of stock farmers in the Brandfort Extension Ward to have their farms planned. 1985. H. Putter
- V.6211/39/4/4: Stock and game farming: the persuasion of stock farmers in the Brandfort Extension Ward to adopt sound veld management practices. 1985. H. Putter
- V.6211/39/4/5: Stock and game farming: the persuasion of stock farmers in the Brandfort Extension Ward to develop a fodder flow programme annually and to implement it. 1985. H. Putter
- V.6211/39/4/6: Stock and game farming: the persuasion of stock farmers in the Brandfort Extension Ward to keep farming records and to adopt financial management practices. 1985. H. Putter
- V.6211/39/5/1: Stock and game farming: the persuasion of stock farmers in the Theunissen Extension Ward to change their attitude towards veld management. 1985. H. Putter
- V.6211/39/5/2: Stock and game farming: the persuasion of stock farmers in the Theunissen Extension Ward to adopt radical veld improvement practices. 1985. H. Putter
- V.6211/39/5/3: Stock and game farming: the persuasion of stock farmers in the Theunissen Extension Ward to have their farms planned. 1985. H. Putter
- V.6211/39/5/4: Stock and game farming: the persuasion of stock farmers in the Theunissen Extension Ward to adopt sound veld management practices. 1985. H. Putter
- V.6211/39/5/5: Stock and game farming: the persuasion of stock farmers in the Theunissen Extension Ward to develop a fodder flow programme annually and to implement it. 1985. H. Putter
- V.6211/39/5/6: Stock and game farming: the persuasion of stock farmers in the Theunissen Extension Ward to keep farming records and to adopt financial management practices. 1985. H. Putter
- V.6211/39/6/1: Stock and game farming: the persuasion of sheep farmers in the Edenburg Extension Ward to adopt improved grazing and stock farming practices. 1985. J.H. Venter
- V.6211/39/6/2: Stock and game farming: the determination of the grazing potential in the grazing capacity zones of the Edenburg Extension Ward. 1985. J.H. Venter
- V.6211/39/6/3: Stock and game farming: the persuasion of stock farmers in the Edenburg Extension Ward to establish perennial cultivated pastures. 1985. J.H. Venter
- V.6211/39/6/4: Stock and game farming: the persuasion of stock farmers in the Edenburg Extension Ward to keep farming records and to adopt financial management practices. 1985. J.H. Venter

- V.6211/39/7/1: Stock and game farming: the persuasion of farmers in the "Duineveld" of Upington North Extension Ward to adapt their stock numbers according to available grazing. 1985. G.N. Esterhuizen
- V.6211/39/7/2: Stock and game farming: to make the farmers aware of the reproduction losses and mortality of mutton sheep. 1985. G.N. Esterhuizen
- V.6211/39/7/3: Stock and game farming: to demonstrate the influence of energy supplementary feeding on the performance of mutton sheep ewes in the Upington North Extension Ward. 1985. G.N. Esterhuizen
- V.6211/39/7/4: Stock and game farming: to identify "top farmers" in the Upington North Extension Ward and stipulate privileges and recognition for them. 1985. G.N. Esterhuizen
- V.6211/39/7/5: Stock and game farming: the persuasion of farmers in the Upington North Extension Ward towards better stock practices by means of the demonstration farm, Massakloutjie. 1985. G.N. Esterhuizen
- V.6211/39/10/1: Stock and game farming: the persuasion of sheep farmers in the Smithfield Extension Ward to adopt recommended grazing management principles. 1988. O.G. Olivier
- V.6211/39/10/2: Stock and game farming: the persuasion of sheep farmers in the Smithfield Extension Ward to adopt stock management principles. 1988. O.G. Olivier
- V.6211/39/10/3: Stock and game farming: the persuasion of sheep farmers in the Smithfield Extension Ward to adopt financial management principles. 1988. O.G. Olivier
- W.6211/39/1/1: Stock and game farming: persuasion of farmers in the Oudtshoorn Extension Ward to establish and utilise drought resistant forage crops. 1985. C.J. Nel
- W.6211/39/1/2: Stock and game farming: persuasion of small stock farmers in the Montagu Extension Ward to cultivate and utilise drought resistant forage and dryland pastures. 1985. E.J.J. Nel
- W.6211/39/1/3: Stock and game farming: persuasion of stock farmers in the Ladismith Extension Ward to establish and utilise drought resistant forage crops and dryland pasture as well as the establishment of Karoobush seed plots for veld reinforcement. 1985. C.F. Scholtz
- W.6211/39/2/1: Stock and game farming: persuasion of small stock farmers in the Vredendal Extension Ward to apply improved grazing management practices based on knowledge of natural grazing plants and their physiological needs. 1985. G. Louw
- W.6211/39/2/2: Stock and game farming: persuasion of farmers in the Vredendal Extension Ward to establish drought forage crops. 1985. G. Louw
- W.6211/39/3/1: Stock and game farming: persuasion of irrigation farmers in the Swellendam Extension Ward to implement optimal use of established pastures in their dairy fodder flow programmes. 1985. J.P. Pietersen
- W.6211/39/3/2: Stock and game farming: persuasion of farmers in the Riversdal Extension Ward to improve the profitability of their dairy herds through the evaluation and interpretation of physical/financial record-keeping results. 1985. J.W. du Preez
- W.6211/39/3/4: Stock and game farming: persuasion of sheep farmers in the Bredasdorp Extension Ward to implement management systems that would result in achieving a higher weaning percentage. 1985. D. Cronje
- W.6211/39/3/5: Stock and game farming: the persuasion of stock farmers in the Swellendam Extension Ward to apply chemical control of annual invader grasses in their dryland legume pastures. 1985. J.P. Pietersen
- W.6211/39/3/6: Stock and game farming: persuasion of sheep farmers in the Swellendam Extension Ward to implement management systems that would increase their income from sheep. 1990. J.D.G. Kasselmann
- W.6211/39/4/1: Stock and game farming: persuasion of sheep farmers in the Malmesbury Extension Ward to implement management practices that would lead to higher weaning percentages. 1985. J.H.F. Roelofse
- W.6211/39/5/1: Stock and game farming: persuasion of dairy farmers in the Durbanville Extension Ward to apply improved management techniques. 1985. G.J. Joubert

- W.6211/39/6/1: Stock and game farming: persuasion of farmers in the Olifantsrivier-Gamka farming area to improve their management and utilisation of lucerne. 1985. B.F.A. Visser
- W.6211/39/8/1: Stock and game farming: persuasion of stock farmers in the Ladismith Extension Ward to implement improved flock management techniques towards better reproduction and weaning percentage. 1989. C.F. Scholtz

- *Management/Bestuur*

- N.6211/41/1/2: Stock and game farming: the analysis of stock and game management systems on veld in the Pongola Extension Ward. 1986. D.M. Gammon

- *Modelling/Modellerling*

- N.6211/42/1/3: Stock and game farming: development of a beef breeding herd simulator programme. 1975. B.P. Louw

CROP FARMING/SAAIBOERDERY

- *Chemical control/Chemiese beheer*

- N.6212/21/1/1: Crop farming: insect pests of maize and their control. 1986. R.A. Bell

- *Situation analysis/Situasiebepaling*

- W.6212/35/1/1: Crop farming: situation analysis of the occurrence of earblight (*Fusarium graminearum* group 2) on wheat in the South Coast subregion of the Langkloof. 1989. W.G.J. Voigt

- *Persuasion/Oorreding*

- K.6212/39/2/1: Crop farming: persuasion of farmers to practise optimal irrigation management and techniques in the Cradock Extension Ward. 1984. P.S. van Heerden
- K.6212/39/2/2: Crop farming: persuasion of farmers to practise optimal irrigation management and techniques in the Somerset East Extension Ward. 1984. P.S. van Heerden
- N.6212/39/1/1: The promotion of improved crop farming practices in the Winterton conservation area. 1976. S.D. le Roux
- V.6212/39/1/1: Crop farming: the persuasion of irrigation farmers in the Rietrivier Irrigation Scheme to apply irrigation scheduling with the aid of the PUTU irrigation model. 1988. P.M. le Roux
- W.6212/39/1/3: Crop farming: persuasion of farmers in the George Extension Ward to incorporate lupins as a crop in their farming systems. 1985. W.G.J. Voigt
- W.6212/39/2/1: Crop farming: persuasion of farmers in the Piketberg Extension Ward to apply improved small grain production techniques. 1985. B.F. Saaiman
- W.6212/39/2/2: Crop farming: persuasion of farmers in the Moorreesburg area of jurisdiction to raise the profitability of farming by the use of physical financial management information. 1985. W. Burger
- W.6212/39/2/3: Crop farming: persuasion of farmers in the Moorreesburg Extension Ward to apply improved weed control techniques. 1986. I.F. Slabbert

MIXED FARMING/GEMENGDE BOERDERY

- *Situation analysis/Situasiebepaling*

- W.6213/35/1/1: Mixed farming: situation analysis in order to establish a databank for the Agricultural Development Centre, George. 1989. J.H. Blomerus

● *Persuasion/Oorreding*

- D.6213/39/1/1: Mixed farming: to persuade crop farmers in the Alexandria Extension Ward to adopt optimal crop production systems. 1986. A.E. du Plessis
- D.6213/39/1/2: Mixed farming: to persuade farmers in the Alexandria ward to implement the water run-off control plans drawn up for their farms. 1987. A.E. du Plessis
- D.6213/39/1/3: Mixed farming: the training of extension personnel in the east coast and central subregions with regard to economic principles and concepts and their practical application. 1987. J.F. Els
- D.6213/39/1/4: Mixed farming: to persuade landowners to effectively protect their lands which are situated above the Gamtoos State Water Scheme and for which run-off control programmes were served. 1987. H.J. Smith
- D.6213/39/1/5: Mixed farming: optimal resource development of the irrigation area in the Hankey magisterial district. 1987. H.J. Els
- H.6213/39/1/1: Persuasion of farmers with mixed farming enterprises in the Bethlehem Extension Ward in order to promote optimal land utilisation. 1981. J.H. de Klerk
- H.6213/39/1/2: Persuasion of farmers with mixed farming enterprises in the Harrismith Extension Ward in order to promote optimal land utilisation. 1983. J.T. van Rooyen
- H.6213/39/1/3: Persuasion of farmers with mixed farming enterprises in the Kroonstad Extension Ward in order to promote optimal land utilisation. 1981. P.J. van Wyk
- H.6213/39/1/4: Persuasion of farmers with mixed farming enterprises in the Bothaville Extension Ward in order to promote optimal land utilisation. 1979. J.I. de V. Burger
- H.6213/39/1/5: Persuasion of farmers with mixed farming enterprises in the Parys Extension Ward in order to promote optimal land utilisation. 1981. A.G.H. Kotze
- H.6213/39/1/6: Persuasion of farmers with mixed farming enterprises in the Klerksdorp Extension Ward in order to promote optimal land utilisation. 1981. C.F. van Eeden
- H.6213/39/1/7: Persuasion of farmers with mixed farming enterprises in the Lichtenburg subregion in order to promote optimal land utilisation. 1982. M.M. Grobbelaar
- H.6213/39/1/8: Persuasion of farmers with mixed farming enterprises in the Heidelberg subregion in order to promote optimal land utilisation. 1978. C.C.A. Breed
- H.6213/39/1/9: Persuasion of farmers with mixed farming enterprises in the Wolmaransstad Extension Ward in order to promote optimal land utilisation. 1986. A.J. Loretz
- H.6213/39/1/10: Persuasion of farmers with mixed farming enterprises in the Potchefstroom Extension Ward in order to promote optimal land utilisation. 1986. J.J. Steyn
- H.6213/39/1/11: Persuasion of farmers with mixed farming enterprises in the Vrede Extension Ward in order to promote optimal land utilisation. 1987. M.J. Marais
- H.6213/39/1/12: Persuasion of farmers with mixed farming enterprises in the Standerton Extension Ward in order to promote optimal land utilisation. 1987. J.A. Rafferty
- H.6213/39/1/13: Persuasion of farmers with mixed farming enterprises in the Frankfort Extension Ward in order to promote optimal land utilisation. 1987. P.J. Smith
- H.6213/39/1/14: Persuasion of farmers with mixed farming enterprises in the Schweizer Reneke Extension Ward in order to promote optimal land utilisation. 1987. A.M. Potgieter
- N.6213/39/1/1: The promotion of optimum production based on resource planning in the Pietermaritzburg Extension Ward. 1986. G. McGrath
- T.6213/39/1/1: Mixed farming: the persuasion of farmers to practise optimal resource utilisation in the High rainfall sourveld area of Belfast. 1985. A. van Deventer
- T.6213/39/2/1: Mixed farming: situation analysis of the irrigation practices in the Groblersdal Extension Ward. 1986. M.G. du Toit
- T.6213/39/2/2: Mixed farming: optimum utilisation and conservation of natural veld. 1990. J.M.D. Venter
- T.6213/39/2/3: Mixed farming: efficient bush control for veld improvement. 1990. J.M.D. Venter

- T.6213/39/2/4: Mixed farming: attaining more efficient fodder utilisation on farming units by means of complete fodder flow programmes. 1990. J.H.D. Venter
- T.6213/39/2/5: The compilation and evaluation of a computer programme designed to simplify irrigation scheduling and to make it available to interested farmers. 1990. M.G. du Toit
- T.6213/39/3/1: Mixed farming: situation analysis of the peach industry in the Silverton Extension Ward. 1986. J.B. Stevens
- T.6213/39/3/2: Mixed farming: determination of a benchmark of the peach industry by means of case studies in the Silverton Extension Ward. 1986. J.B. Stevens
- T.6213/39/3/3: Mixed farming: training of peach farmers in the implementation of adopted practices. 1987. J.B. Stevens
- T.6213/39/3/4: Training of and advice to officers and farmers in financial planning of farms. 1990. W.D. Haines
- T.6213/39/3/5: Mixed farming: ad hoc advisory services to farmers in the Silverton Extension Ward. 1990. P.J.E. Erasmus
- T.6213/39/3/6: Mixed farming: the compilation of guidelines for intensive sheep farming on planted pastures. 1990. P.J.E. Erasmus.
- T. 6213/39/3/7: Reconnaissance survey to identify the problems and needs of vegetable farmers in the Silverton Extension Ward. 1991. J.J. du Preez
- T.6213/39/3/8: Meaningful fertiliser recommendations to farmers in the Silverton Extension Ward according to relative information. 1990. J.J. du Preez
- T. 6213/39/3/9: Evaluation of fertiliser recommendation to farmers in the Silverton Extension Ward 1991. J.J. du Preez
- T.6213/39/3/10: Fodderflow planning for individual farmers in the Silverton Extension Ward. 1990. J.B. Stevens
- T.6213/39/3/11: The editorial handling of newsletters "Agrinuus" and "Mini-Agrinuus" and their distribution in the Silverton Extension Ward. 1990. T.B. Stevens
- T.6213/39/3/12: The compilation of guidelines for the identification of the most important veld grasses, trees and problem plants within the Silverton Extension Ward. 1991. J.B. Stevens
- T.6213/39/4/1: The education of cattle and game farmers in farm management with special reference to record keeping. 1989. H.G. Brockman
- T.6213/39/4/2: The development of a benchmark for cotton production under irrigation in the Pontdrift area. 1989. B.J.M. Nel
- T.6213/39/5/1: Fodderflow planning for individual farmers. 1990. L. de Beer
- T.6213/39/5/3: The establishment of an organisational structure for Agricultural Development. 1990. L. de Beer
- T.6213/39/5/4: The efficient implementation and administration of the soil conversion scheme and the collection and dispersion of relevant production data. 1987. L. van der Walt
- T.6213/39/5/5: The issuing of crop production information in a more acceptable format to Extension staff and the farming community in the south-eastern Transvaal subregion. 1990. G.J.P. van der Linde
- T.6213/39/5/6: Creating an awareness among farmers of specific fodderflow problems (in winter and summer) by means of case studies carried out at individual farms. 1991. L. van der Walt
- T.6213/39/5/7: A determination of the situation of the milk farming industry in the south-eastern Transvaal subregion. 1991. D. Müller
- T.6213/39/5/8: To give on request advice/information to individual crop farmers in the south-eastern Transvaal subregion. 1991. G.P.J. van der Linde
- T.6213/39/6/1: Creating an awareness among farmers of specific fodderflow problems (in winter and summer) by means of case studies at individual farmers. 1990. D.L. van Niekerk
- T.6213/39/6/3: The efficient implementation and administration of the soil conversion scheme and the collection and dispersion of relevant production data. 1990. S.L. Mann

- T.6213/39/6/4: Fodderflow planning for the individual farmer. 1991. D.L. van Niekerk
- T.6213/39/7/1: To create a need to practise efficient veld management in farmers via a communication programme. 1990. P.J. Vermaas
- T.6213/39/7/2: To persuade farmers to use and manage cultivated pastures with discretion and to investigate the adaptability and utilisation of certain pastures and fodder crops. 1990. P.J. Vermaas
- T.6213/39/8/1: The gathering and computerisation of relevant information on adapted fodder crops under dryland conditions and irrigated land. 1990. D.J.J. Burger
- T.6213/39/9/1: Situation analysis to determine a frame of reference for small stock farming in the Brits Extension Ward. 1989. J.R. Wallis
- T.6213/39/9/2: Table grape block competition in the Brits and Rustenburg Extension Wards. 1989. J.R. Wallis
- T.6213/39/9/3: The determination of norms and production guidelines for lucerne production by means of a demonstration unit in the Brits Extension Ward. 1990. J.R. Wallis
- T.6213/39/10/1: Optimisation of irrigation management - a case study. 1990. P. Eloff
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